T · ·Mobile·

June 27, 2019

VIA ELECTRONIC FILING

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: ***Ex Parte Notification***

GN Docket No. 18-122, *Expanding Flexible Use of the 3.7 GHz to 4.2 GHz Band*

Dear Ms. Dortch:

On June 25, 2019, Russell Fox of Mintz, Dennis Roberson, Nat Natarajan, and Mike Needham of Roberson and Associates LLC ("Roberson"),[1] and I held separate meetings with Erin McGrath and Chris McGillen of Commissioner O'Rielly's office and Aaron Goldberger of Chairman Pai's office regarding the above-referenced proceedings.

During the meetings, the representatives from Roberson presented a study (the "Roberson Study") that evaluates the availability of fiber and cost to connect every 3.7-4.2 GHz band ("C-band") receive location to fiber as a replacement for satellite delivery of content. We made substantially the same points as those reflected in the *ex parte* letter we submitted last week covering our meetings with other members of the Commission's staff, a copy of which is attached (and a copy of the Roberson Study is attached to that letter).[2]

Pursuant to Section 1.1206(b)(2) of the Commission's rules, an electronic copy of this letter is being filed in the above-referenced docket, and a copy is being provided to the staff with whom we met. Please direct any questions regarding this filing to me.

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[1] The Roberson representatives participated by telephone.

[2] *See* Letter from Steve B. Sharkey, Vice President, Government Affairs, Technology and Engineering Policy, T-Mobile, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 (filed June 21, 2019).

Respectfully submitted,

/s/ Steve B. Sharkey

Steve B. Sharkey
Vice President, Government Affairs
Technology and Engineering Policy

Attachment

cc: (each by e-mail)
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June 21, 2019

VIA ELECTRONIC FILING

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: ***Ex Parte Notification***

GN Docket No. 18-122, *Expanding Flexible Use of the 3.7 GHz to 4.2 GHz Band*

Dear Ms. Dortch:

On June 19, 2019, John Hunter of T-Mobile USA, Inc. ("T-Mobile"),[1/] Dennis Roberson, Nat Natarajan, and Mike Needham (by telephone) of Roberson and Associates LLC ("Roberson"), Russell Fox and Angela Kung of Mintz, and I met with Donald Stockdale, Becky Schwartz, Anna Gentry, Joel Taubenblatt, and Lauren Earley of the Wireless Telecommunications Bureau; Giulia McHenry, Patrick DeGraba, Margaret Wiener, Martha Stancill, Alex Simmons, Paul LaFontaine, and Evan Kwerel of the Office of Economics and Analytics; Michael Ha of the Office of Engineering and Technology; Jim Schlichting and Jose Albuquerque of the International Bureau; Brian Smith of the Office of the Managing Director; and by telephone with Peter Daronco, Paul Powell, Matthew Pearl, Thomas Derenge, and Deborah Broderson.

On June 20, 2019, John Hunter of T-Mobile, Dennis Roberson and Nat Natarajan of Roberson, and Russell Fox of Mintz separately met with William Davenport, Chief of Staff and Senior Legal Advisor to Commissioner Starks, Umair Javed, Legal Advisor to Commissioner Rosenworcel, and Will Adams, Legal Advisor to Commissioner Carr.

During the meetings, the representatives from Roberson presented the attached study (the "Roberson Study"), which evaluates the availability of fiber and cost to connect every 3.7-4.2 GHz band ("C-band") receive location to fiber as a replacement for satellite delivery of content. The Roberson Study finds that fiber is widely available in both urban and rural areas and that every C-band earth station receive location in the country could be connected to fiber for approximately $1 billion,[2/] demonstrating that it is cost effective to clear all 500 megahertz of C-

[1/] T-Mobile USA, Inc. is a wholly owned subsidiary of T-Mobile US, Inc., a publicly-traded company.

[2/] The cost for deploying fiber ranges from $167.7 million to $1.42 billion depending on the number of earth station locations and assumptions regarding the extent of existing fiber deployment.

band spectrum in order to make the band available for Fifth Generation ("5G") wireless services. Use of fiber as an alternative to satellite delivery of services would not only advance competitive 5G services, but it also offers the opportunity to expand fiber into currently unserved or underserved areas, potentially closing the digital divide and providing new economic opportunity in those locations.

Making Sufficient Spectrum Available for Competitive 5G Services Depends on Changing the Status Quo for Delivering Content

The record in this proceeding is clear that significantly more than the 180 megahertz of spectrum offered by the C-Band Alliance ("CBA") must be made available to satisfy the demand for spectrum for 5G services.[3/] During the meetings, we noted that T-Mobile has proposed that the Commission conduct an incentive auction – including satellite operators and earth station registrants – as a means to apply market-based forces to find a more appropriate balance of spectrum for 5G use versus satellite use.[4/] Unlike the CBA proposal, which would conduct a private transaction with CBA members controlling supply and all other relevant conditions, an incentive auction would be a true open and transparent market-based mechanism. Moreover, a Commission-conducted incentive auction would best conform to the requirements of the Communications Act and could return value to U.S. taxpayers.

The Roberson Study Demonstrates the Feasibility of Substituting Fiber for C-Band Earth Stations

An important component of maximizing the amount of spectrum available for 5G services is providing alternative transport to ensure the reliable delivery of the content currently carried by

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3/ *See, e.g.*, Comments of T-Mobile USA, Inc., GN Docket No. 18-122, *et al.*, at 11-12 (filed Oct. 29, 2018) (urging the Commission to free 80 to 100 megahertz of C-band spectrum per wireless provider on a nationwide basis); Comments of CTIA, GN Docket No. 18-122, *et al.*, at 9 (filed Oct. 29, 2018) ("For an effective mid-band 5G initiative, a substantial amount of 3.7-4.2 GHz spectrum, in the range of hundreds of megahertz, needs to be transitioned nationwide."); Comments of Verizon, GN Docket No. 18-122, at 9-10 (filed Oct. 29, 2018) (urging the Commission to ensure that hundreds of megahertz of C-band spectrum is transitioned to flexible use); Comments of Ericsson, GN Docket No. 18-122, at 10 (filed Oct. 29, 2018) ("[T]he Commission should make sure that hundreds of megahertz of usable spectrum is transitioned for 5G and other next generation services as quickly as possible."); Comments of Nokia, GN Docket No. 18-122, *et al.*, at 7 (filed Oct. 29, 2018) ("The public interest demands that the Commission require a plan and path forward for clearing additional spectrum in the band over and above the recently proposed 200 MHz."); *see also* Michael O'Rielly, Commissioner, FCC, Remarks at the Brooklyn 5G Summit 2019, at 3 (Apr. 25, 2019), https://docs.fcc.gov/public/attachments/DOC-357184A1.pdf ("Hopefully, the satellite incumbents who are willing to surrender their spectrum rights will be able to find a way to increase the amount to be reallocated to 300 or more megahertz . . . ."); Brendan Carr, Commissioner, FCC, Keynote Remarks of FCC Commissioner Brendan Carr at the WISPAmerica Convention, at 4 (Mar. 20, 2019), https://docs.fcc.gov/public/attachments/DOC-356655A1.pdf ("One proposal on the table involves clearing around 200 MHz of the 500 MHz total to be used for mobile. I think we can do better.").

4/ *See* Letter from Steve B. Sharkey, Vice President, Government Affairs, Technology and Engineering Policy, T-Mobile, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 (filed Feb. 15, 2019) ("T-Mobile Feb. 15 *Ex Parte* Letter").

satellites using C-band spectrum. Fiber is widely deployed today and is used for the delivery of services and content that require extremely high reliability, including telecommunications and emergency services.[5/] However, some parties in this proceeding have questioned both the cost and availability of fiber as a replacement for the delivery of content.[6/] Accordingly, T-Mobile engaged Roberson to conduct a data-driven analysis of the availability of fiber and cost of providing fiber links to replace C-band satellite earth station receive stations.

As described more fully below, the Roberson Study concludes that, using conservative assumptions, fiber can be provided to existing earth station sites for less than $1 billion – and potentially significantly less depending on actual conditions. And, even assuming the complete absence of fiber serving today's earth station locations – an unrealistic scenario – it would only cost approximately $1.4 billion to provide new fiber to those sites. Each of these costs is significantly less than the revenue that would likely be generated from a C-band incentive auction.[7/]

Fiber Can Meet Content Transmission Needs. T-Mobile recognizes the important content that is transmitted from C-band satellites to earth stations today. However, reliable delivery of this content does not mean that the *status quo* of satellite delivery must be maintained. The Commission should adopt a framework that takes advantage of advanced technologies as an alternative to current satellite delivery. Fiber – both existing and new – can provide reliable delivery of content and can be deployed at a fraction of the value of the C-band spectrum. Auction proceeds would readily cover the costs of replacing satellite earth stations with fiber links and, in an incentive auction, earth station registrants that elect to receive an incentive payment to relinquish their use of the spectrum would also receive a payment based on their valuation of the spectrum. As T-Mobile has demonstrated, the value to earth station registrants

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[5/] *See Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion*, 2019 Broadband Deployment Report, FCC 19-44, ¶ 3 (rel. May 29, 2019) ("During 2018, for example, broadband providers, both small and large, deployed fiber networks to 5.9 million new homes, the largest number ever recorded."); *see also* Lisa R. Youngers, *Why 9-1-1 Needs Fiber* (Apr. 30, 2019), http://www.broadbandworldnews.com/author.asp?section_id=713&doc_id=751137 (explaining that because of its reliability "[f]iber forms the foundation of the highest-quality public safety communications systems"); Fiber Broadband Association, *Over-the-Top Trend is a Fiber Opportunity* (May 5, 2018), http://www.broadbandworldnews.com/author.asp?section_id=713&doc_id=743510 ("OTT services depend on reliable, high-speed, low latency Internet connections and the ability to consume an immense amount of data – and fiber leads all other access technologies in delivering each of these capabilities.").

[6/] *See, e.g.*, Letter from Matthew S. DelNero, Covington, Counsel for the Content Companies, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122, at 2 (filed June 7, 2019); Letter from Mark Williams, President, Faith Broadcasting Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122, at 2 (filed May 20, 2019).

[7/] As T-Mobile has noted before, it is reasonable to assume a nationwide spectrum value for the C-band of $0.30 per MHz-pop, or $48 billion on a nationwide basis, an estimate consistent with analyst projections. *See* T-Mobile Feb. 15 *Ex Parte* Letter at Attachment at 2; Reply Comments of T-Mobile USA, Inc., GN Docket No. 18-122, *et al.*, at 21 n.71 (filed Dec. 11, 2018).

of moving to alternate transport can be very significant.[8/] And both earth station registrants that receive an incentive payment and those that do not can receive compensation for the cost to move to fiber, or another alternative – generated from auction proceeds.

Roberson Study Methodology and Assumptions. Because the ability to use fiber as a substitute for the C-band is such an important component of the Commission's consideration of this matter, it is critical that the Commission base its analysis on sound assumptions. The Roberson Study does that:

- First, because the cost of providing fiber to current earth station sites will vary depending on whether those earth stations are in rural or urban areas, the Roberson Study categorized areas within the continental U.S. as either "rural" or "urban" based on the population density in zip codes (zip code tabulation areas).
- Second, in order to assign a (rural vs. urban) cost to provide fiber to earth station sites, the Roberson Study mapped the location of the earth stations in the C-band onto representative rural and urban partial economic areas ("PEAs") – PEA 121 (Altoona, PA) and PEA 3 (Chicago, IL), respectively. Based on those results, it found that even in urban PEAs like Chicago, some earth stations were located in rural areas, and in some otherwise rural PEAs, some earth stations were located in urban areas. Overall, according to its mapping, it concluded that it was reasonable to assume that 40 percent of earth stations are in urban areas and 60 percent are in rural areas today.
- Third, based on the mapping it performed, it calculated the distance between fiber runs and earth stations in both urban and rural areas. It concluded that the median distance to fiber is 272 meters in urban areas and 465 meters in rural areas.
- Finally, the Roberson Study assigned a value to the cost of providing fiber to an earth station location.

Roberson Study Results. Based on the foregoing, the Roberson Study found the following:

- If all earth station locations either licensed or with applications for registrations pending (including filed, but not accepted) are attached to fiber, the cost will be approximately **<u>$369 million</u>**. In addition to the assumptions above, this cost assumes that fiber is available to earth station sites in 90 percent of urban locations and in 70 percent of rural locations. The remaining locations would be served by *new* fiber runs.
- However, Roberson also calculated the cost of providing fiber to earth stations if not a single earth station could take advantage of existing fiber, *i.e.*, if new fiber was required to reach existing earth stations. Even in that case, in which there is **<u>no</u>** probability of fiber already connected in rural or urban areas, the cost to provide fiber will be **<u>$1.4 billion</u>** (the far left blue bar on page 30 of the attached presentation).[9/]

[8/] *See* T-Mobile Feb. 15 *Ex Parte* Letter at 4 (explaining that "most earth station registrants in that PEA could receive between $15 million and $36 million per earth station to clear all 500 megahertz").

[9/] In the chart on page 30 of the attachment, the x-axis shows the likelihood of fiber in rural areas. Within each bar grouping along the x-axis, the assumptions about urban availability are shown in different colors. The chart shows the cost of providing fiber under 24 different urban/rural availability combinations, with the y-axis showing the cost under each scenario.

The Roberson Study therefore demonstrates that providing earth station sites with fiber as an alternative to satellite C-band downlinks is a cost-effective method for clearing all 500 megahertz of C-band spectrum, while still allowing earth stations to continue their operations.

The Roberson Study Used Conservative Estimates

For among the following reasons, the actual costs of providing fiber are likely to be even lower than the estimates that the Roberson Study provides:

- Number of earth stations – The maximum potential fiber cost of between $369 million and $1.4 billion is based on all earth stations licensed and for which registration applications have been submitted. The number of earth stations in operation is likely less.
- Co-located antennas – The analysis assumes that fiber must be run to each licensed site. But in many instances, antennas are co-located, meaning that costs have been double, triple (or more) counted for co-located sites.
- Greater fiber availability – The Roberson Study created assumptions of the average length of fiber needed to extend to earth station locations based on a limited number of publicly available sources of fiber availability. However, there is likely more fiber available than those sources indicate, meaning that the distances to earth stations are likely lower.

Fiber Deployment Will Provide Benefits Beyond the C-Band. Finally, we noted that relocating earth stations to fiber could help close the digital divide and provide new economic opportunities for rural, unserved and underserved communities. While most areas of the country are already served with fiber, any additional fiber-builds, particularly to rural, unserved, and underserved areas, can have broader benefits. In particular, this additional fiber can be shared with others to provide connectivity where little may exist today. The Commission should therefore take the opportunity presented in this proceeding to enable greater fiber connectivity in rural, unserved, and underserved areas, while simultaneously making available much needed spectrum for 5G, by adopting the incentive auction approach for the C-band proposed by T-Mobile.

* * *

Pursuant to Section 1.1206(b)(2) of the Commission's rules, an electronic copy of this letter is being filed in the above-referenced docket and a copy is being provided to the staff with whom we met. Please direct any questions regarding this filing to me.

Respectfully submitted,

/s/ Steve B. Sharkey

Steve B. Sharkey
Vice President, Government Affairs
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Estimating Cost of Fiber Replacement for C-Band Sites

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Roberson and Associates LLC
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19 June 2019

Outline

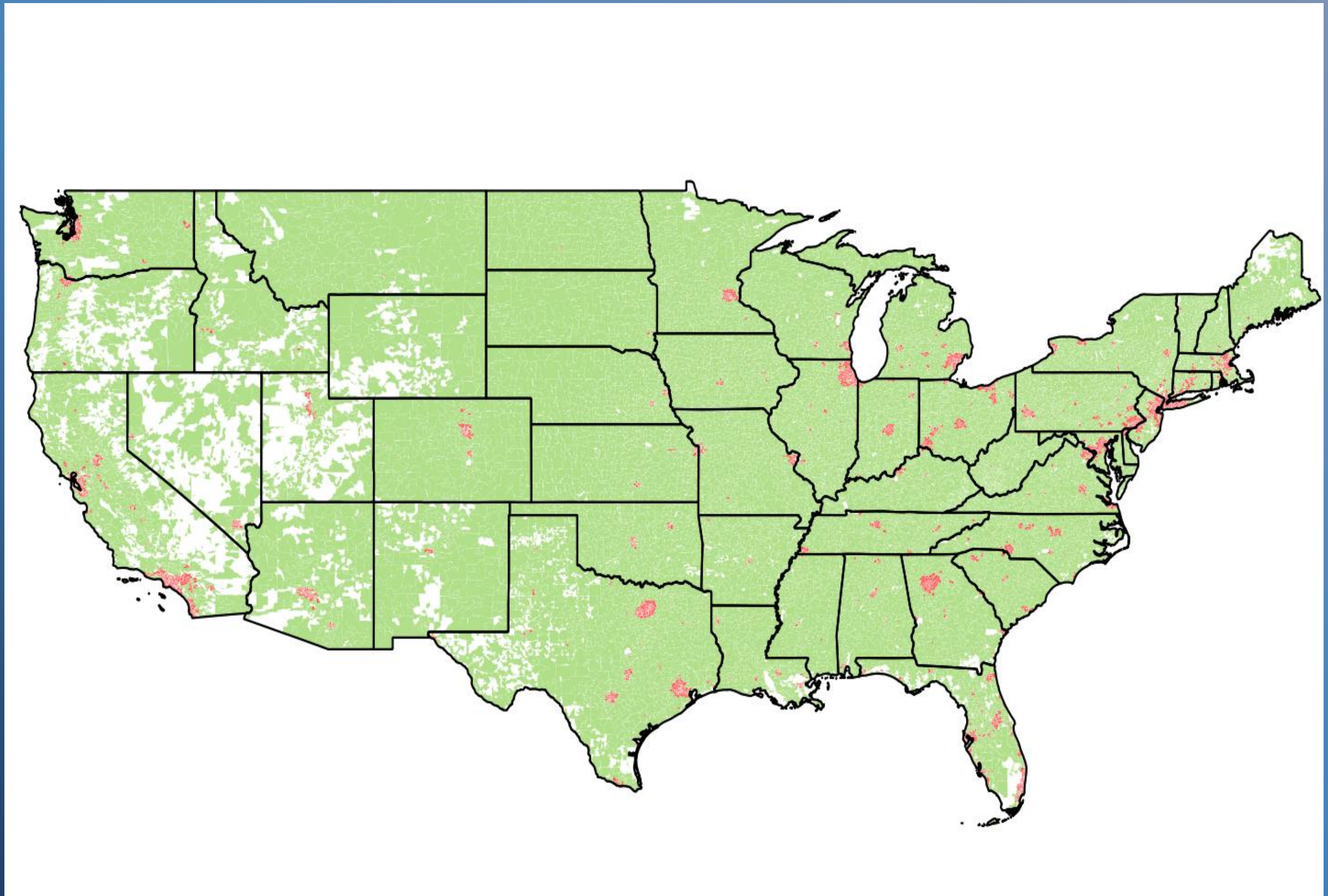
- Methodology and Summary
- Mapping of Satellite Earth Stations
- Fiber Availability in the US
- Fiber Penetration Analysis with Representative Example PEAs
- Cost Models and Sensitivity analysis
- Conclusion

Methodology and Summary

- Analyzed IBFS databases to get up-to-date count of Receive Only and Tx-Rx Satellite Earth Stations (SES). Our findings are in line with similar but independent assessments.
- Mapped SES sites into urban and rural categories based on population density in zip codes (ZCTAs).
- Developed cost model to get first-cut estimates of cost for providing fiber connection to each SES location on a nationwide basis (All 415 PEAs).
- Used conservative assumptions for parameter values (using ACA filings) to obtain bounds on cost
- Detailed fiber availability analyses (based on a subset of available fiber runs) indicate actual fiber runs expected to be shorter than assumed by models.
- Further optimization of fiber runs leveraging geographic clusters of sites possible to further decrease cost.
- Performed sensitivity analysis with respect to key parameters.
- Median distance to fiber in representative PEAs: 272 meters in urban and 465 meters in rural PEAs.
- Results show the economic feasibility of providing fiber as an alternative to satellite C-Band downlink with fiber deployment costs of less than $1 Billion.

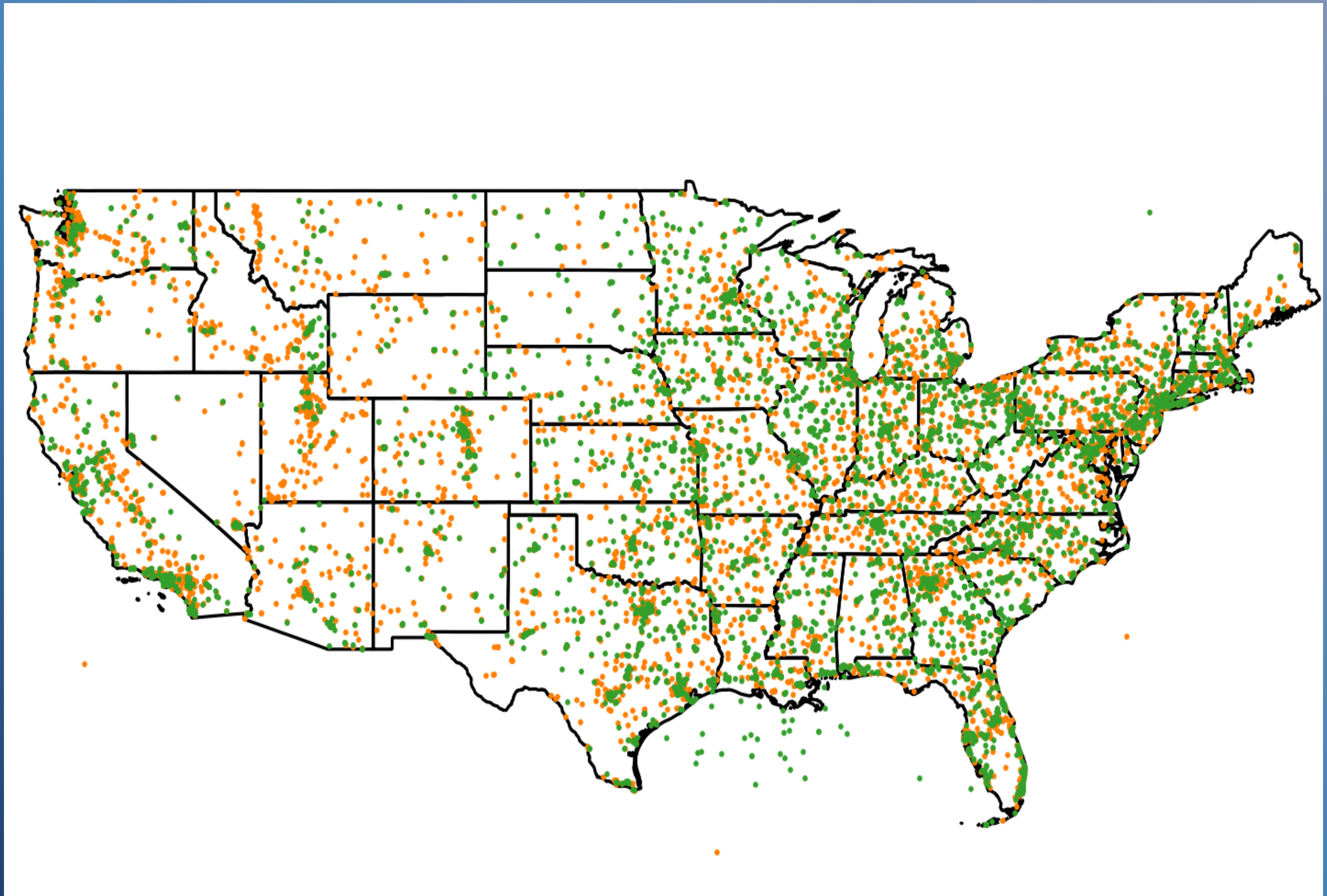
Population Density of ZCTAs in CONUS

- Zip Code Tabulation Areas (ZCTAs)
  - Over 33,000 in US
- Broken down by rural vs. non-rural
  - “Rural” defined as < 1000 per square-mile – shown in green
  - “Urban” defined as ≥ 1000 per square-mile – shown in pink
  - Water and mostly uninhabited areas lack ZCTAs



C-Band Receive Sites in CONUS (RO and Tx-Rx)

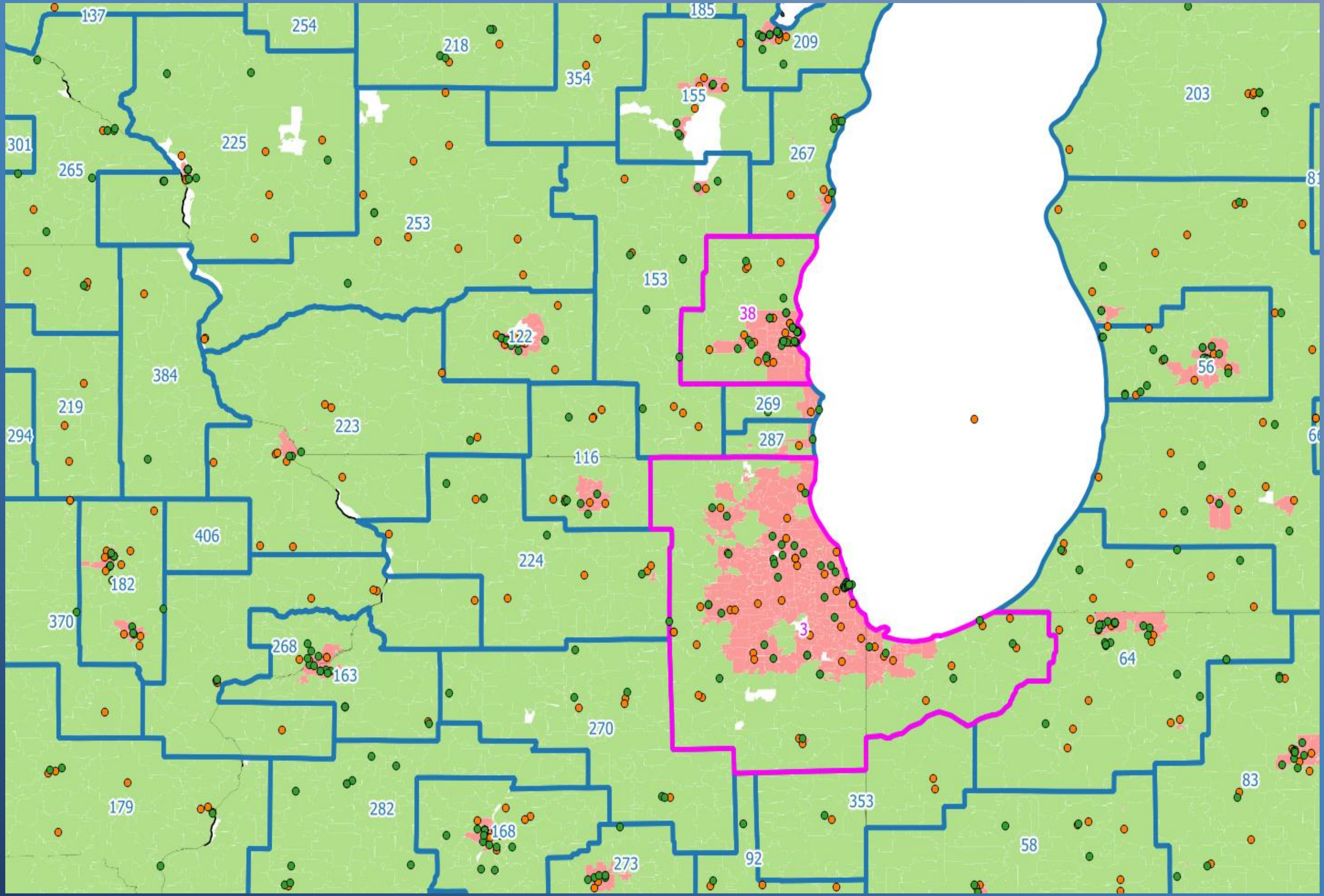
- Satellite Earth Station sites from IBFS database
  - 3700 – 4200 MHz
  - Receive-Only (RO) or Transmit-Receive (Tx-Rx)
  - 13,704 overall
- Graphed based on registration status
  - Currently Licensed or Pending (6607) – shown in Green
  - Filed but not processed (7097) – shown in Orange
  - Exclude those with status "Closed"



Data downloaded from IBFS on 15-Mar-2019
(some erroneous location data in the data base)

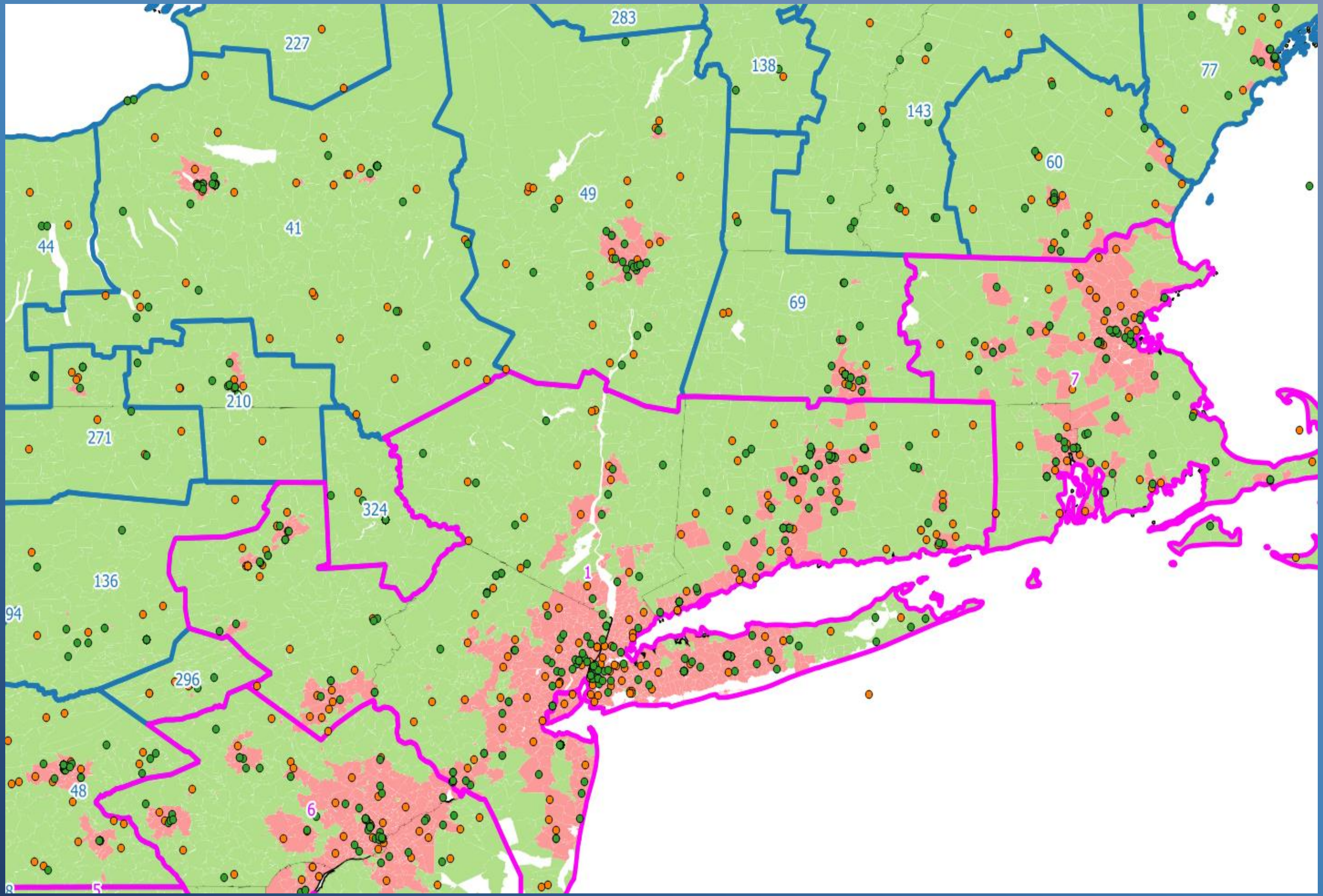
C-Band Sites in Chicago / Milwaukee Area

- Urban (pink) and Rural (green) ZCTA areas within each PEA
- C-band sites
  - Current/Pending (green)
  - Submitted/Not Accepted (orange)
- Significant amount of rural areas even in populous PEAs



C-Band Sites in Boston / New York / Baltimore-Washington PEAs

- Urban (pink) and Rural (green) ZCTA areas within each PEA
- C-band sites
  - Current/Pending (green)
  - Submitted/Not Accepted (orange)
- Significant amount of rural areas even in populous PEAs



PEA Stats and C-Band Site Counts (Top 25 listed below)

PEA	PEA Name	POP (2010)	Area (sq-mi)	Pop/sq-mi	C-Band Site Count	Urban Site Count	Rural Site Count	% Sites Urban	% Sites Rural
1	New York, NY	25,237,061	19,330	1305.6	398	273	125	68.6%	31.4%
2	Los Angeles, CA	19,410,169	48,403	401.0	396	251	138	63.4%	34.8%
3	Chicago, IL	9,366,713	6,712	1395.5	96	73	23	76.0%	24.0%
4	San Francisco, CA	9,027,937	13,845	652.1	175	128	47	73.1%	26.9%
5	Baltimore-Washington	7,842,134	7,902	992.4	196	145	51	74.0%	26.0%
6	Philadelphia, PA	7,587,252	8,613	881.0	126	88	38	69.8%	30.2%
7	Boston, MA	6,776,035	6,485	1044.9	120	94	26	78.3%	21.7%
8	Dallas, TX	6,452,472	9,541	676.3	135	104	31	77.0%	23.0%
9	Miami, FL	6,291,880	11,582	543.2	135	106	28	78.5%	20.7%
10	Houston, TX	5,891,999	7,963	740.0	116	90	26	77.6%	22.4%
11	Atlanta, GA	5,435,312	10,396	522.8	246	200	46	81.3%	18.7%
12	Detroit, MI	5,137,479	5,937	865.4	92	72	20	78.3%	21.7%
13	Orlando, FL	4,562,642	13,732	332.3	146	88	57	60.3%	39.0%
14	Cleveland, OH	4,096,678	7,689	532.8	131	70	61	53.4%	46.6%
15	Phoenix, AZ	3,817,117	9,224	413.8	108	75	33	69.4%	30.6%
16	Seattle, WA	3,792,218	10,063	376.8	105	64	41	61.0%	39.0%
17	Minneapolis-St. Paul, MN	3,390,091	7,123	475.9	96	64	32	66.7%	33.3%
18	San Diego, CA	3,095,313	4,258	726.9	63	49	12	77.8%	19.0%
19	Portland, OR	3,022,643	14,479	208.8	100	54	46	54.0%	46.0%
20	Denver, CO	2,789,669	4,685	595.4	101	73	28	72.3%	27.7%
21	Tampa, FL	2,783,243	2,683	1037.4	75	65	10	86.7%	13.3%
22	Sacramento, CA	2,722,415	12,299	221.4	77	34	43	44.2%	55.8%
23	Pittsburgh, PA	2,399,667	5,741	418.0	86	46	40	53.5%	46.5%
24	Saint Louis, MO	2,396,938	5,311	451.3	61	38	23	62.3%	37.7%
25	Cincinnati, OH	2,196,428	5,978	367.4	51	35	16	68.6%	31.4%

Data on Fiber Availability in the United States

- Multiple sources of data on fiber availability exist in the public domain. A variety of sources that are available (visible and downloadable) for the public is used in this study.

- Some individual fiber service providers have published their fiber network maps – regions of the US (spanning multiple states) or local within a single state. Other providers keep their fiber deployments confidential for business or other reasons.

- There are public websites such as:
  - https://broadbandnow.com/Fiber-Providers/
  - https://decisiondata.org/COVERAGE
  - https://decisiondata.org/internet-providers-by-zip-code-plus-tv/

- Please see a partial list of fiber service providers in the next two slides.
- Fiber availability may also be extracted from Form 477 data. Limited use for this study.
  - https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477

1253 providers offer Fiber service in the US.

(Source: BROADBANDNOW® See https://broadbandnow.com/Fiber-Providers/)

Partial list of Providers Offering Fiber Service (listed in decreasing order of population coverage) (1 of 2)

Service Provider	Population Coverage	# of States & union territories covered	Max Speed
Verizon Fios	34,396,280	10	940 mbps
AT&T Fiber	20,403,883	21	1000 mbps
Frontier Communications	10,923,883	8	100 mbps
CenturyLink	8,156,001	53	1000 mbps
Google Fiber	2,127,072	10	1000 mbps
Windstream	1,816,354	44	1000 mbps
Cincinnati Bell	1,335,440	5	1000 mbps
C Spire Fiber	1,265,251	8	1000 mbps
Consolidated Communications	1,106,682	14	1000 mbps
Armstrong	982,867	5	1000 mbps
Metronet	910,151	3	1000 mbps
Hawaiian Telcom	687,829	1	1000 mbps
En-Touch Systems	535,246	1	1000 mbps
Shentel	524,635	4	1000 mbps
Ultimate Internet Access	523,446	1	1000 mbps
TDS Telecom	486,643	23	1000 mbps
Veracity Networks	403,788	1	1000 mbps
Sonic	397,789	1	1000 mbps
EPB	359,866	2	1000 mbps
North State Communications	302,294	1	1000 mbps
Peoples Telephone Cooperative	279,575	1	1000 mbps
UTOPIA	270,973	1	1000 mbps
Hotwire Communications	236,830	9	1000 mbps
Point Broadband	232,352	4	1000 mbps
Summit Broadband	219,539	1	1000 mbps
Air Advantage	214,740	1	1000 mbps
Columbia Energy	211,731	1	100 mbps
Campus Communications Group	201,239	5	1000 mbps
CentraCom	195,682	1	1000 mbps

Service Provider	Population Coverage	# of States and union territories covered	Max Speed
Optimum by Altice	183,136	3	1000 mbps
Horry Telephone Cooperative	165,487	1	1000 mbps
Comporium Communications	159,541	2	1000 mbps
Bristol Tennessee Essential Services	156,823	1	1000 mbps
Direct Communications	154,618	4	100 mbps
MTCO Communications	153,465	1	1000 mbps
NTS Communications	138,124	2	1000 mbps
LocalTel Communications	132,976	1	100 mbps
Community Fiber Solutions	129,914	2	50 mbps
Morris Broadband	124,470	1	1000 mbps
LUS Fiber	116,690	1	1000 mbps
CDE Lightband	113,984	1	1000 mbps
GoNetspeed	110,396	2	1000 mbps
GVTC Communications	109,212	1	1000 mbps
EATEL	107,417	1	1000 mbps
i3 Broadband	105,755	1	1000 mbps
Dalton Utilities	102,599	1	1000 mbps
LightSpeed Communications	100,907	2	1000 mbps
Benton PUD	97,360	1	100 mbps
Owensboro Municipal Utilities	96,656	1	1000 mbps
Allo Communications	91,270	1	1000 mbps
Kaptel	90,592	1	100 mbps
Brandenburg Telecom	88,004	1	1000 mbps
Paul Bunyan Telephone	87,608	1	1000 mbps
Socket Telecom	87,307	2	1000 mbps
City of Longmont	83,709	1	1000 mbps
Casair	82,825	1	1000 mbps

Partial list of Providers Offering Fiber Service (2 of 2)

Plateau	80,135	2	1000 mbps
Ting	79,530	5	1000 mbps
Nex-Tech	79,506	2	1000 mbps
Greenlight Networks	78,680	1	1000 mbps
Home Telecom	77,825	1	1000 mbps
Jackson Energy Authority	76,235	1	1000 mbps
Troy Cablevision	75,436	1	1000 mbps
Empire Access	75,066	1	1000 mbps
Farmers Telecommunications Cooperative	69,057	1	1000 mbps
Yadtel	68,821	1	100 mbps
Orbitel Communications	68,665	1	100 mbps
Co-Mo Connect	66,418	1	1000 mbps
Ocala Telecom	66,297	1	100 mbps
GCI Communication	66,246	2	1000 mbps
Clearnetworx	64,614	1	977 mbps
Bulloch Telephone Cooperative	63,353	1	1000 mbps
Jaguar Communications	63,050	1	1000 mbps
Highland Telephone Cooperative	63,022	2	1000 mbps
Morristown Utility FiberNET	62,544	1	1000 mbps
Cascade Networks	62,126	2	100 mbps
FTC	60,758	1	1000 mbps
Twin Lakes Telephone	60,385	1	1000 mbps
Skybest Communications	59,423	3	1000 mbps
Douglas Fast Net	59,036	1	1000 mbps
Silver Star Communications	57,948	2	1000 mbps
NineStar Connect	57,773	1	1000 mbps
Pend Oreille Valley Networks	57,716	2	100 mbps
Greenlight	56,684	1	1000 mbps
Smithville Communications	56,045	1	1000 mbps
Lumos Networks	55,889	2	1000 mbps

CTC	55,586	1	250 mbps
Mainstream Fiber Networks	55,028	1	200 mbps
North Central Telephone Cooperative	54,878	2	1000 mbps
South Central Rural Telephone	54,877	1	1000 mbps
Eagle Communications	54,850	1	100 mbps
VTX Communications	54,840	1	1000 mbps
Slic Network Solutions	54,546	1	500 mbps
Golden West Telecommunications	54,525	2	100 mbps
WK&T	52,915	2	1000 mbps
Randolph Telephone Membership Corporation	52,550	1	100 mbps
Acentek	52,234	2	1000 mbps
United Services	51,908	1	1000 mbps
Midwest Connections	51,387	2	1000 mbps
Pineland Telephone Company	50,913	1	1000 mbps
Adams Networks	50,009	1	1000 mbps
SenaWave	49,736	1	1000 mbps
Nittany Media	49,477	1	1000 mbps
Burlington Telecom	49,373	1	1000 mbps
Wilkes Communications	48,580	1	1000 mbps
HBC	47,337	1	1000 mbps
Bluewave Communications	46,887	1	100 mbps
Planters Rural Telephone Cooperative	46,553	1	1000 mbps
USA Communications	46,136	2	200 mbps
US Internet	44,293	1	1000 mbps
Spanish Fork Community Network	43,188	1	1000 mbps
Foothills Broadband	43,149	1	1000 mbps
Palmetto Rural Telephone Cooperative	42,892	1	500 mbps
Winn Telecom	42,763	1	1000 mbps
Blue Ridge Mountain EMC	42,128	2	1000 mbps
Star Communications	41,823	1	100 mbps
BOLT Fiber Optic Services	41,678	1	1000 mbps
CommZoom	41,541	1	1000 mbps
Cedar Falls Municipal Communications Utility	40,971	1	1000 mbps
Montana Opticom	40,558	1	1000 mbps

For the sake of brevity the remaining providers in the list of 1253 fiber service providers are not shown.

Fiber availability continues to expand over time in rural, remote and/or sparsely populated areas of the US.

Fiber Penetration Analysis

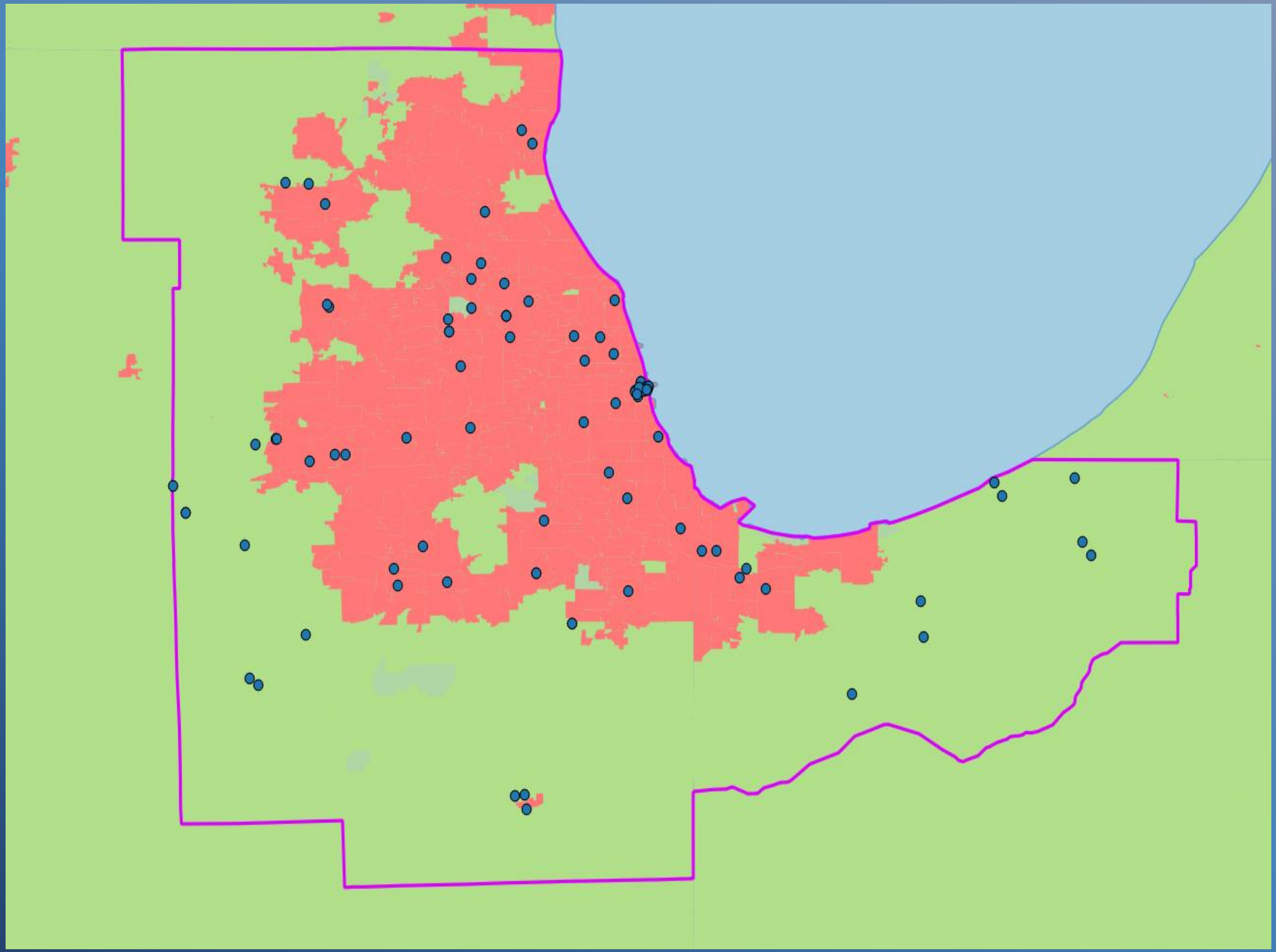
Choose two representative PEAs for in-depth study

1. Urban PEA (Chicago and vicinity)
   - Total 96 SES sites located in ~ 75% Urban and 25% Rural ZCTAs

2. Rural PEA (Altoona, PA)
   - Total 35 SES sites located in ~ 25% Urban and 75% Rural ZCTAs

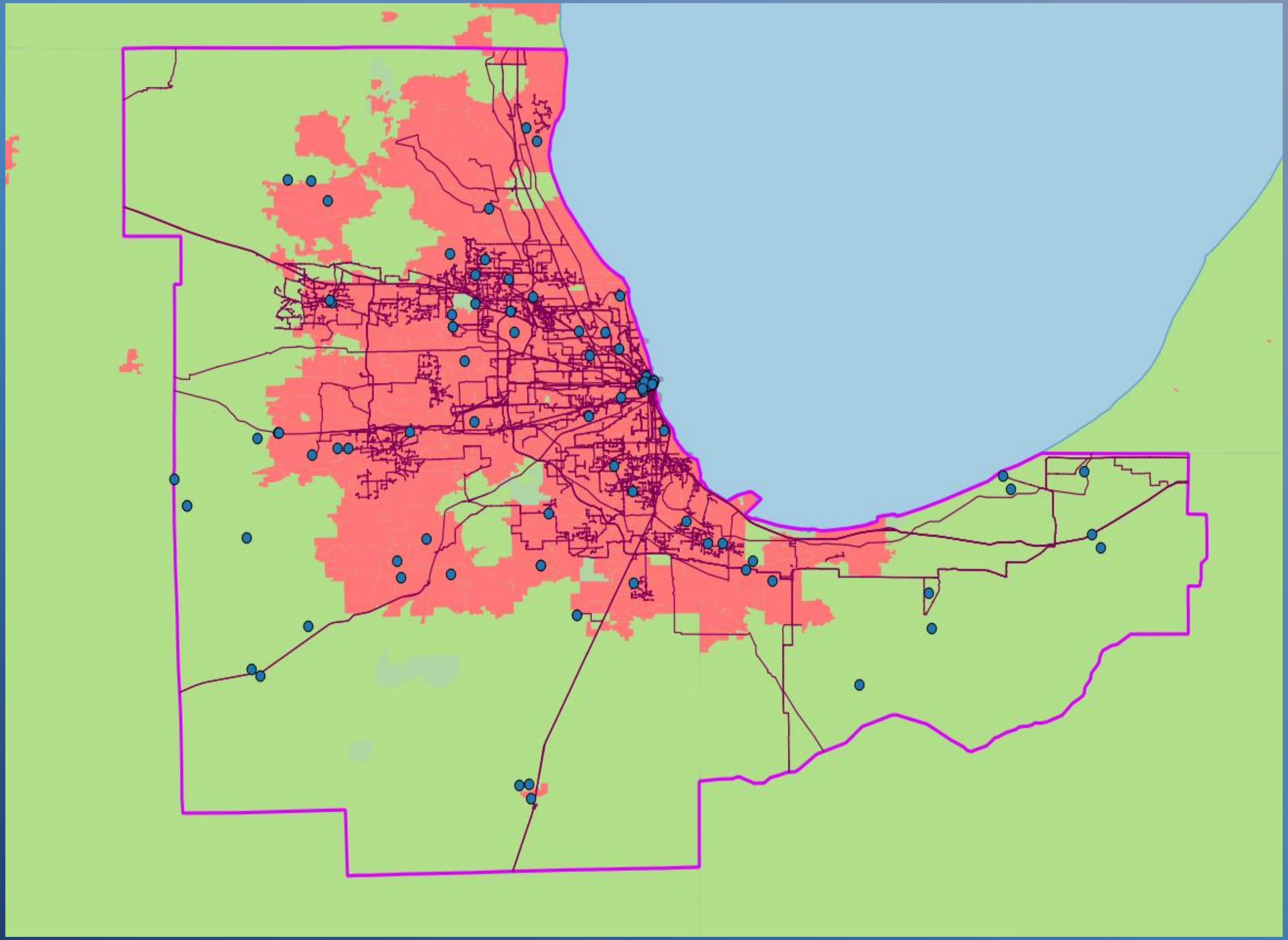
C-Band Sites in PEA 3 (Chicago, IL)

- 96 C-Band sites in PEA 3
  - Current/Pending and Not Accepted (per 3/15/19 IBFS database)
- Urban (pink) and Rural (green) ZCTA areas within each PEA
  - Based on population density <1000 (rural) or ≥ 1000 (urban)
  - About 75% of sites in Urban, 25% in Rural



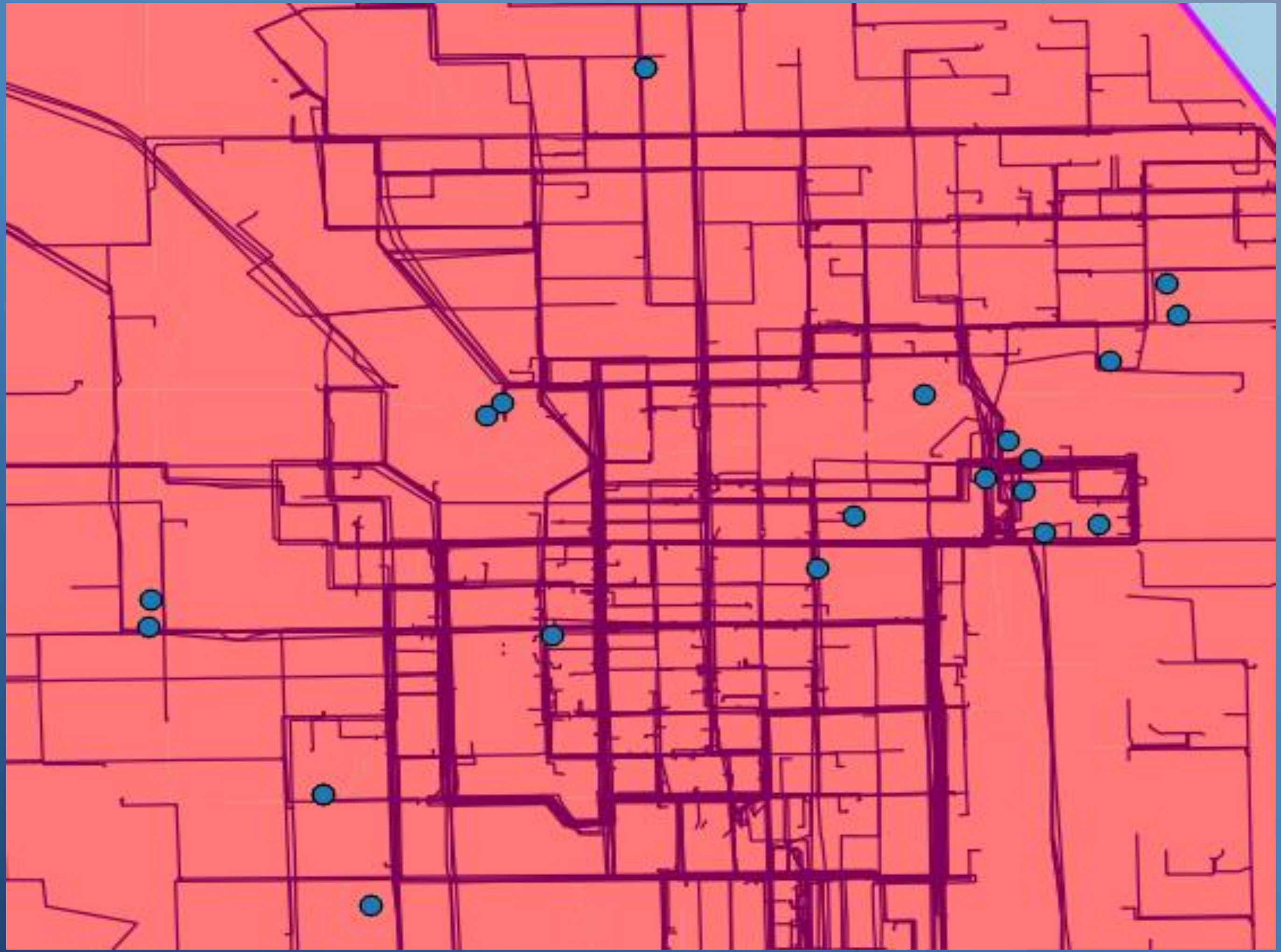
C-Band Sites and Fiber Runs in PEA 3 (Chicago, IL)

- Fiber run maps for 4 providers:
  - Windstream
  - Crown Castle
  - WOW
  - ZAYO
- Limited availability of analyzable fiber maps
  - Plots are based on a subset of all fiber runs that exist
- Example fiber providers in PEA 3 (not mapped):
  - AT&T
  - Unite
  - Metronet
  - CenturyLink
  - First
  - Acme



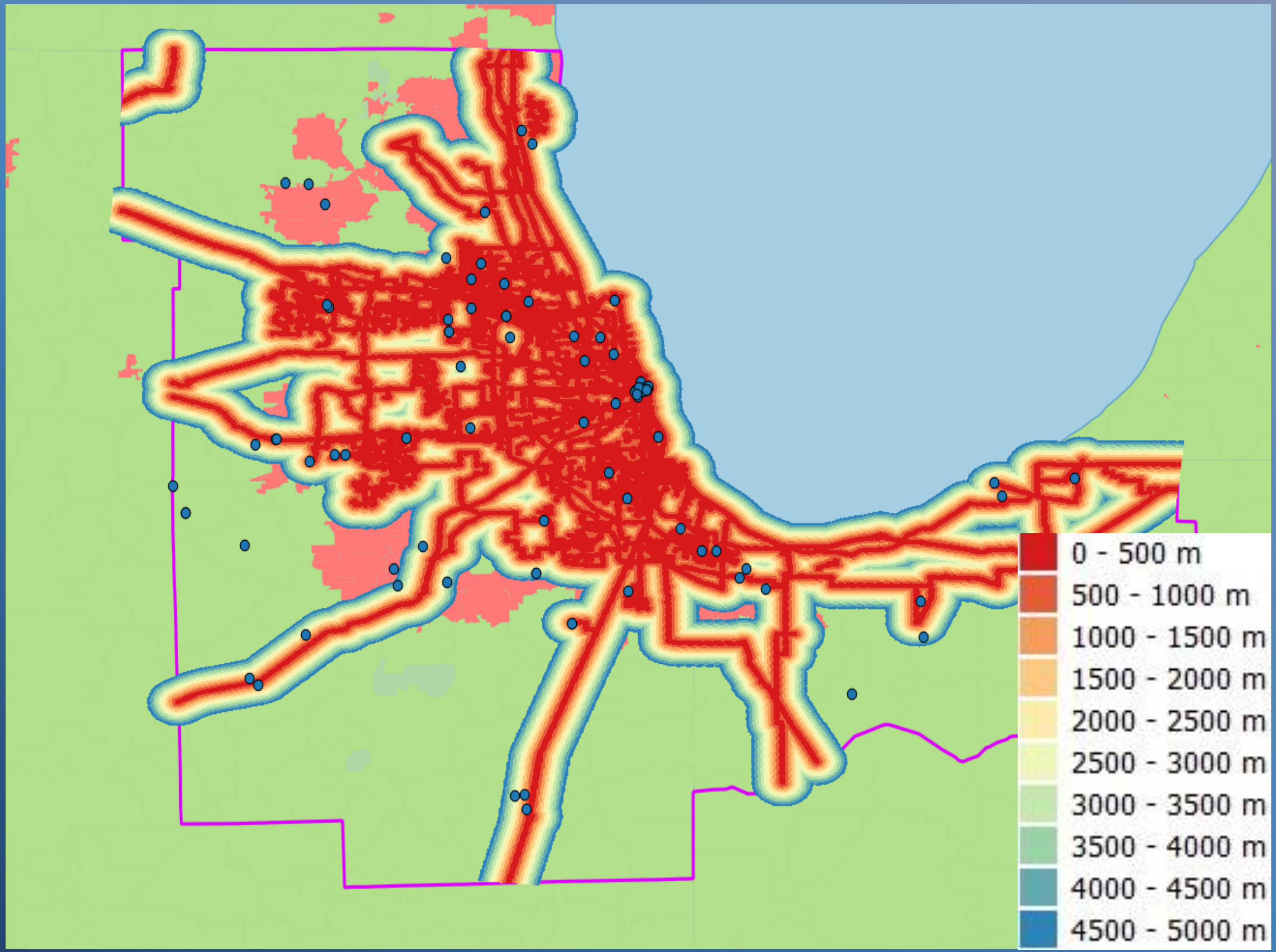
C-Band Sites and Fiber Runs in PEA 3 (Chicago – Detailed)

- Zooming in on Fiber run maps downtown Chicago
  - Dense coverage in inner-city
  - Most sites are in close proximity to fiber runs



Distance Proximity Map for Fiber Runs in PEA 3 (Chicago, IL)

- Color-code distance to nearest fiber run at any point in PEA
  - Used to estimate distance of fiber runs to connect C-Band sites
  - Distance estimates conservative – based on subset of available fiber

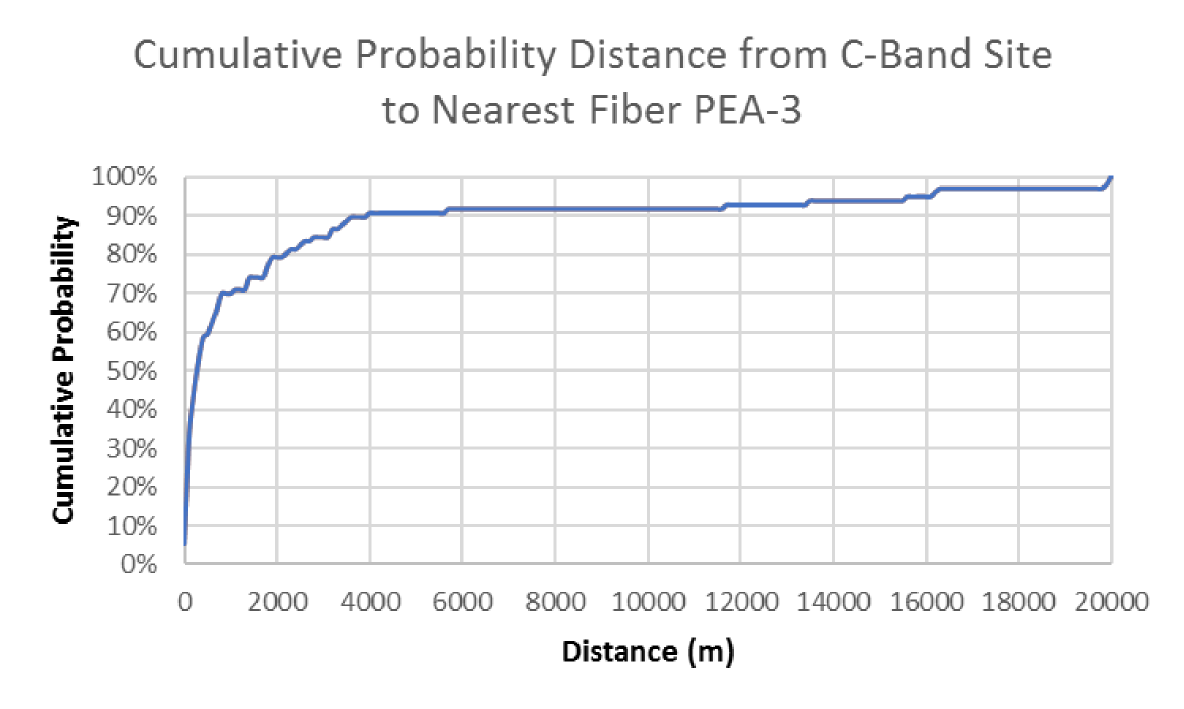


Distances of C-Band Sites to Fiber Runs in PEA 3 (Chicago, IL)

- See that roughly 1/3 of sites within 100 meters of a fiber run
- 70% within 1000 meters
- 90% within 5000 meters

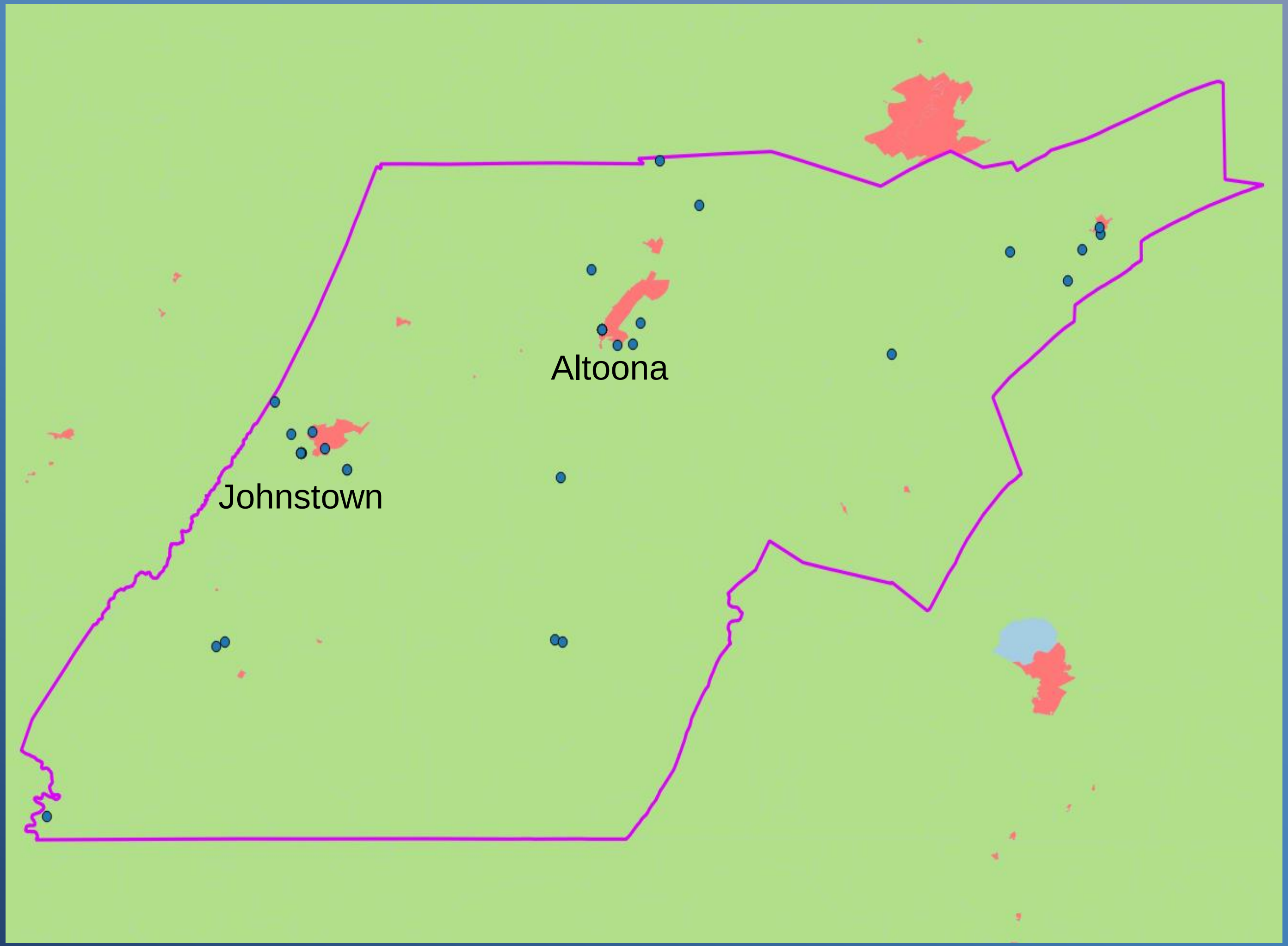
Basic Stats	
Average Distance (m)	2,076
Median Distance (m)	272
Sum Distance (m)	199,264

Distance (m)	No. Sites	Percent	Cumulative
0 - 10	5	5.2%	5.2%
10 - 100	26	27.1%	32.3%
100 - 200	11	11.5%	43.8%
200 - 500	15	15.6%	59.4%
500 - 1000	10	10.4%	69.8%
1000 - 2000	9	9.4%	79.2%
2000 - 5000	11	11.5%	90.6%
5000 - 10,000	1	1.0%	91.7%
10,000 - 20,000	8	8.3%	100.0%
Total	96	100.0%	100.0%



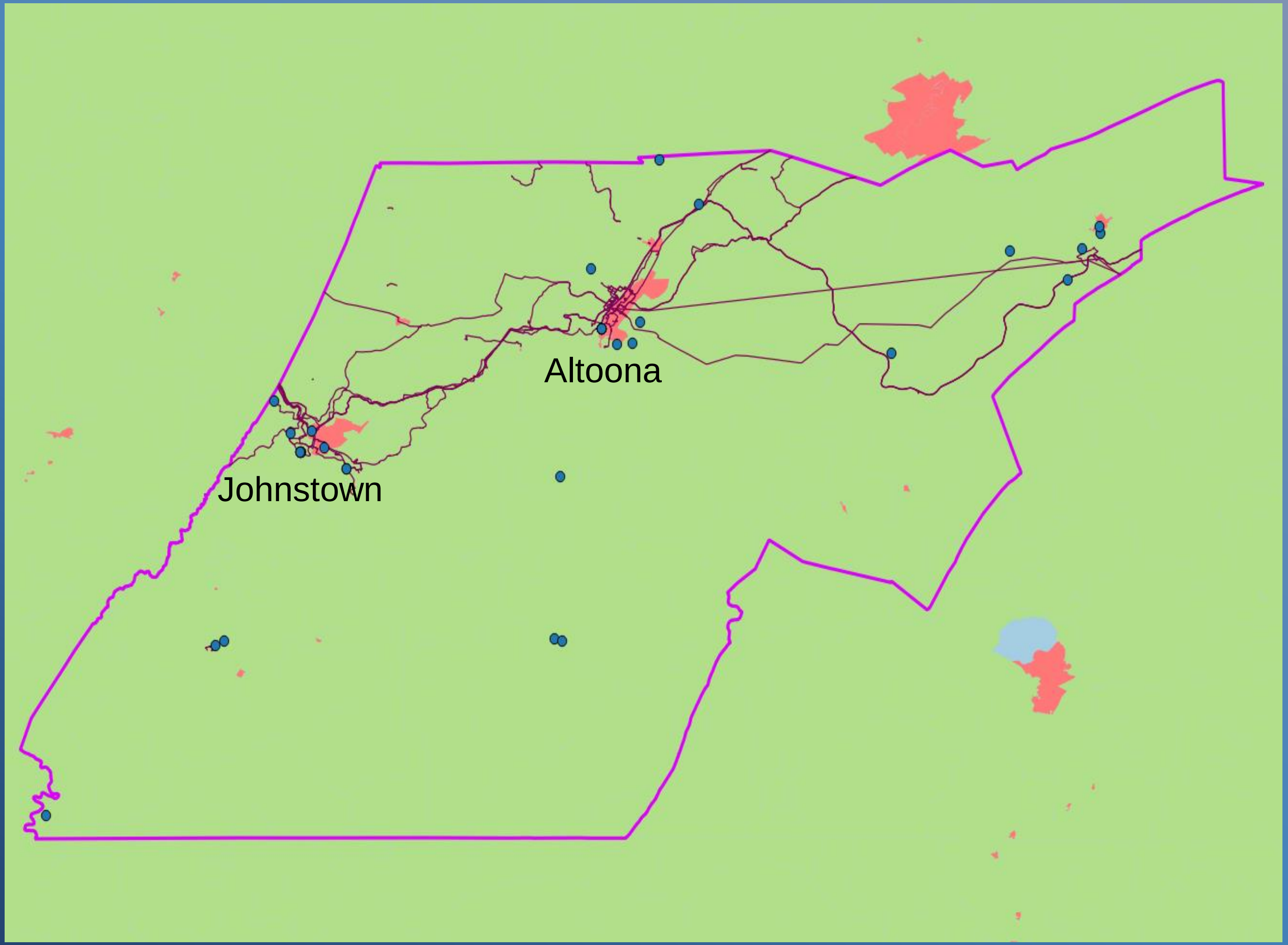
C-Band Sites in PEA 121 (Altoona, PA)

- 35 C-Band sites in PEA 121
  - Current/Pending and Not Accepted (per 3/15/19 IBFS database)
- Urban (pink) and Rural (green) ZCTA areas within each PEA
  - Based on population density <1000 (rural) or $\geq$ 1000 (urban)
  - About 25% of sites in Urban, 75% in Rural



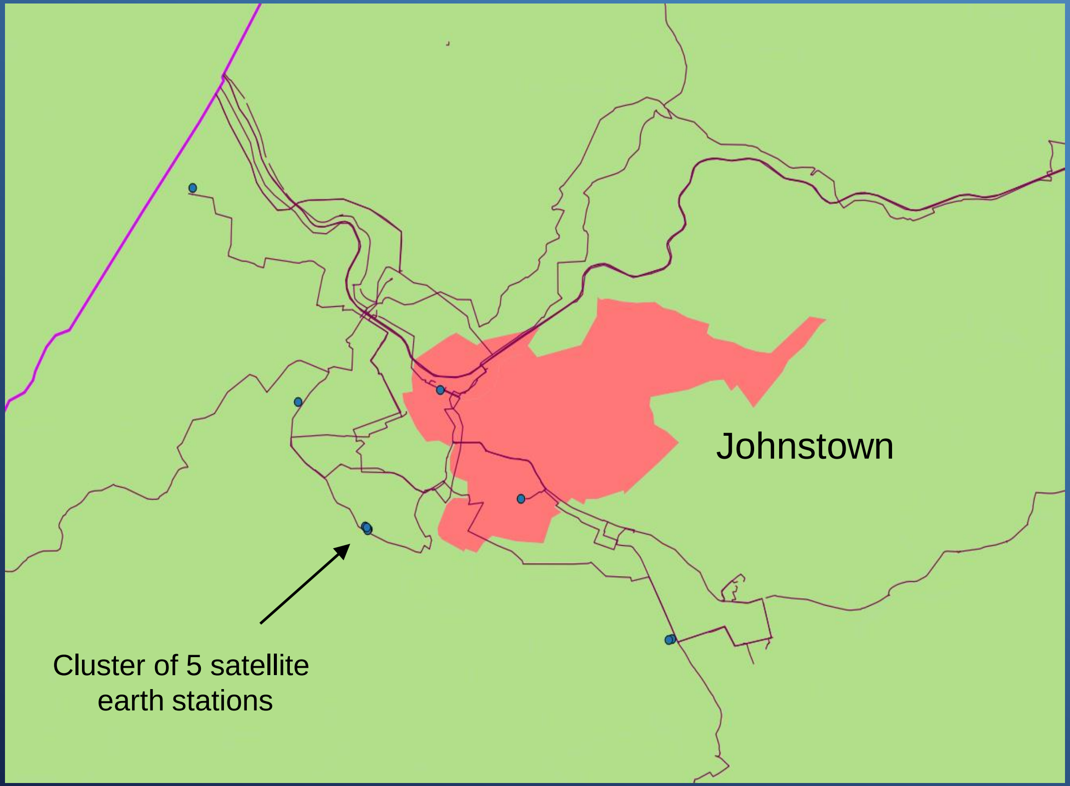
C-Band Sites and Fiber Runs in PEA 121 (Altoona, PA)

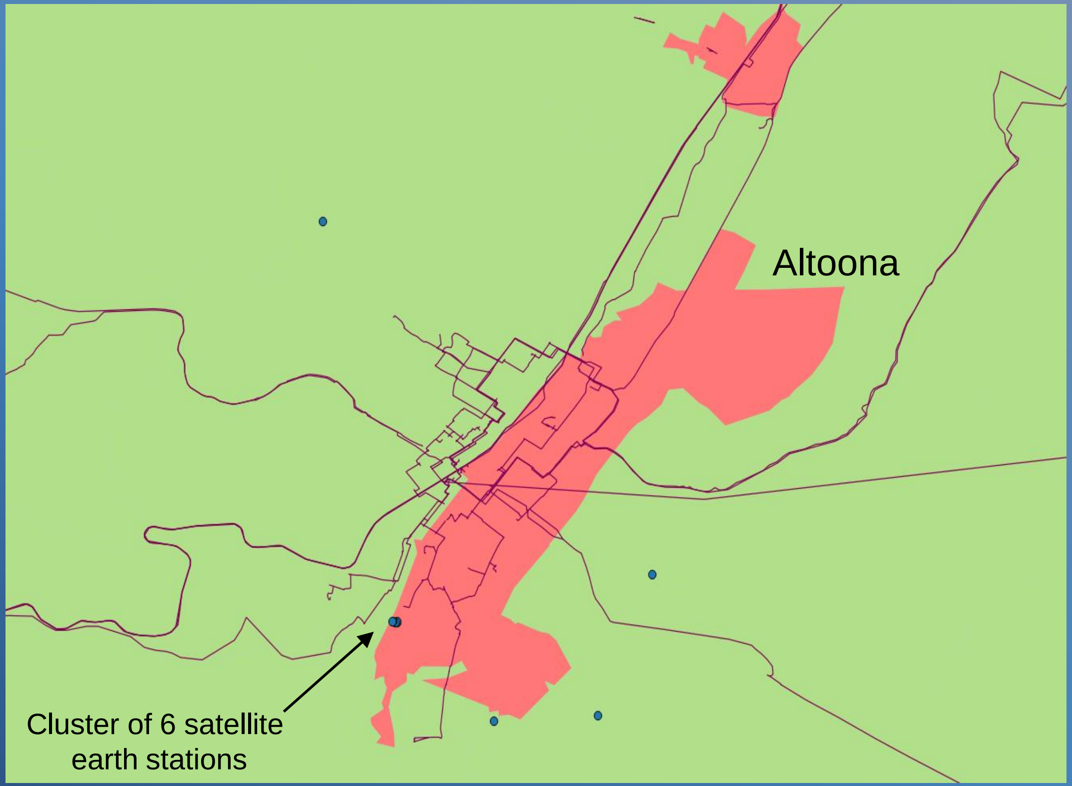
- Fiber run maps for 3 providers
  - Windstream
  - ZAYO
  - Pennsylvania Research and Education Network
- Limited availability of analyzable fiber maps
  - Plots are based on a subset of all fiber runs that exist
- Example fiber providers in PEA 121 (not mapped):
  - Atlantic Broadband
  - Nittany Media
  - Armstrong
  - CenturyLink
  - Crown Castle



C-Band Sites and Fiber Runs in PEA 121 (Zoom)

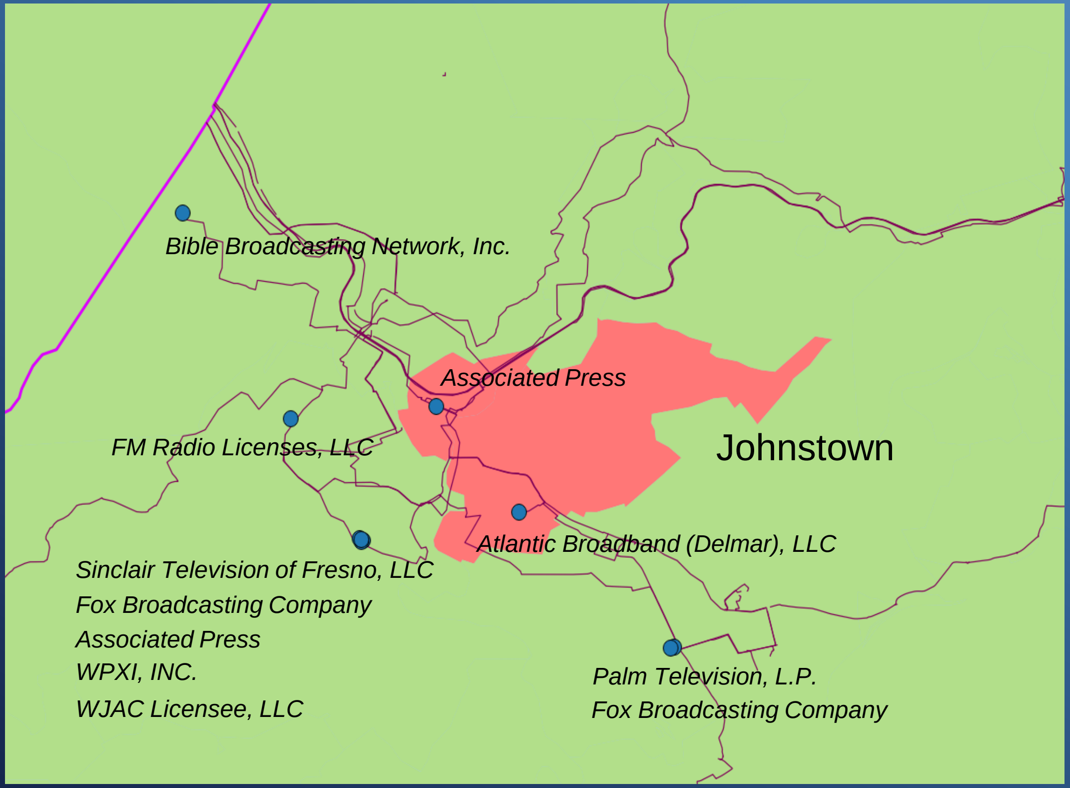
- Zoom in on Fiber run maps downtown Altoona and Johnstown
  - Main population centers of PEA

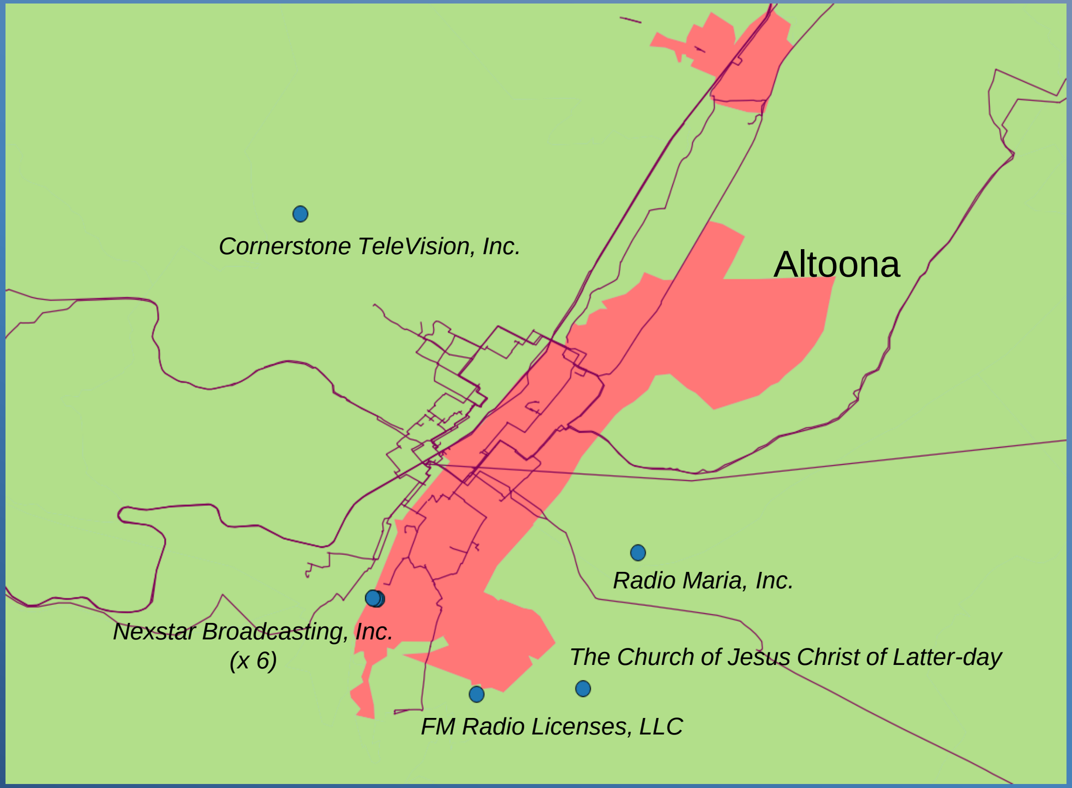




C-Band Sites and Fiber Runs in PEA 121 (Zoom)

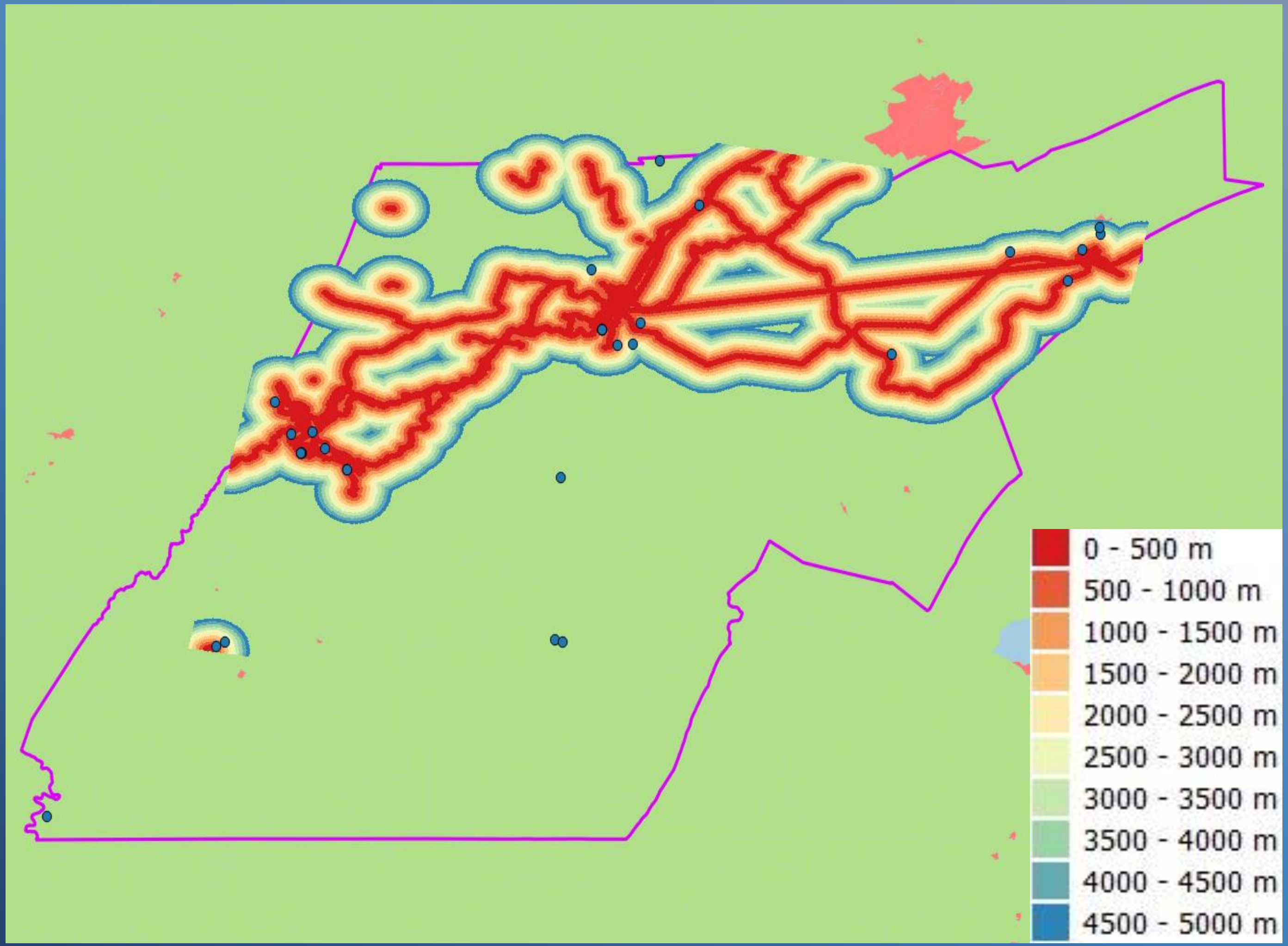
- Zoom in on Fiber run maps downtown Altoona and Johnstown
  - Main population centers of PEA
  - Applicant names shown





Distance Proximity Map for Fiber Runs in PEA 121 (Altoona, PA)

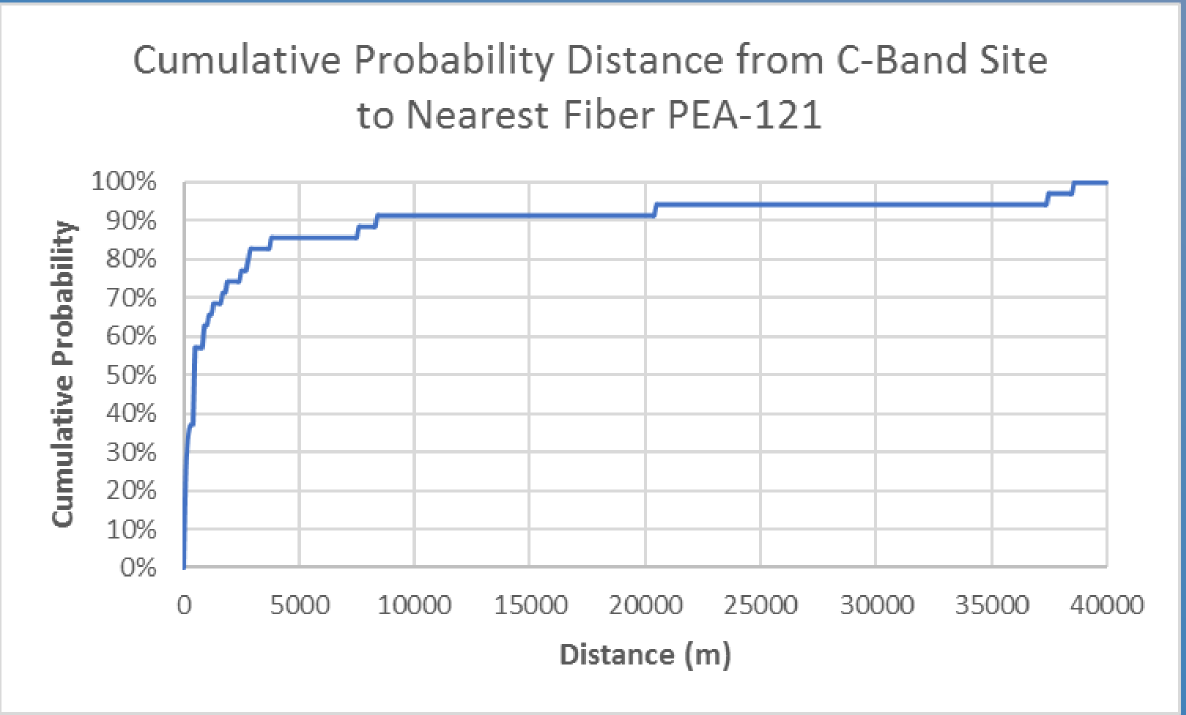
- Color-code distance to nearest fiber run at any point in PEA
  - Used to estimate distance of fiber runs to connect C-Band sites
  - Distance estimates conservative – based on subset of available fiber



Distances of C-Band Sites to Fiber Runs in PEA 121 (Altoona, PA)

- See that roughly 1/4 of sites within 100 meters of a fiber run
- 63% within 1000 meters
- 86% within 5000 meters

Basic Stats	
Average Distance (m)	3,889
Median Distance (m)	465
Sum Distance (m)	136,120



Distance (m)	No. Sites	Percent	Cumulative
0 - 10	0	0.0%	0.0%
10 - 100	9	25.7%	25.7%
100 - 200	3	8.6%	34.3%
200 - 500	8	22.9%	57.1%
500 - 1000	2	5.7%	62.9%
1000 - 2000	4	11.4%	74.3%
2000 - 5000	4	11.4%	85.7%
5000 - 10,000	2	5.7%	91.4%
10,000 - 20,000	0	0.0%	91.4%
20,000 - 40,000	3	8.6%	100.0%
Total	35	100.0%	100.0%

C-Band Sites in PEAs - Statistics

	Current and Pending Sites	All Filed Sites
No. Urban and Rural C-Band Sites*	6,403	13,437
Avg. No. Sites per PEA	15.5	32.5
No. Urban C-Band Sites	2,708	5,189
Avg. Urban Sites per PEA	6.5	12.5
No. Rural C-Band Sites	3,695	8,248
Avg. Rural Sites per PEA	8.9	19.9

The two columns (**Current and Pending Sites** as well as **All Filed Sites**) are used to establish lower and upper bounds on estimating costs of fiber replacement

* Sites outside of defined urban or rural areas not included

Cost Models for Urban and Rural Sites
(Nationwide replacement, All 415 PEAs – current and pending)

Current and Pending sites, Nationwide replacement in all PEAs analysis			
# of Satellite C-Band Receivers in urban sites	2,708	# of Satellite C-Band Receivers in rural sites	3,695
Average # of blocks to fiber access	1	Average # of blocks to fiber access	20
Length of city block = 660 x 330 feet	495	Length of a block = 660 feet	660
Average length of fiber (feet)	495	Average length of fiber (feet)	13,200
Cost per foot of fiber wire ($ per foot)	110	Cost per foot of fiber wire ($ per foot)	10
Probability 1 Gbps available (%)	90	Probability 1 Gbps available (%)	70
Cost of wiring urban site with fiber (including laying fiber, fiber termination costs)	56,450	Cost of wiring rural site with fiber (including laying fiber, pole attachment and fiber termination costs	137,500
Cost of replacig satellite w/ fiber for all existing urban sites	15,286,660	Cost of replacing satellite w/ fiber for all existing rural sites	152,418,750

Total Estimated Cost (All 415 PEAs) ~ $ 167.7 Million

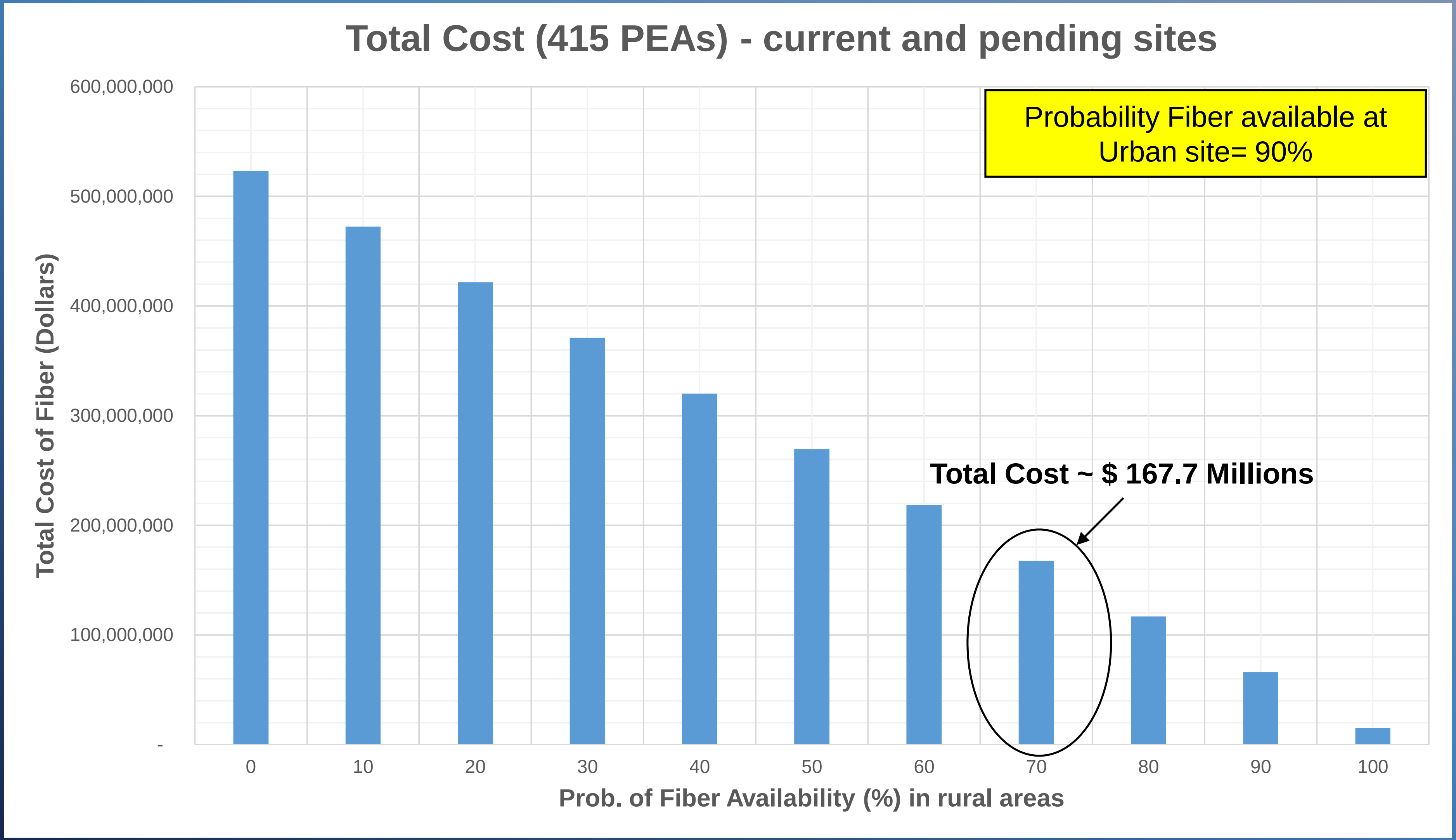
Note: In our model, the cost of wiring a rural site is $ 137,500. This is more conservative than estimated cost of $ 127,500 for providing 10 miles of aerial fiber under the assumptions of the American Cable Association. It is also comparable to the cost of providing 2.5 miles of underground fiber in remote rural areas. Note that regulatory or rights-of-way fees could further impact costs. See page 17 in Comments of the American Cable Association, GN Docket No. 17-183, October 2, 2017.

Cost Models for Urban and Rural Sites
(Nationwide replacement, All 415 PEAs – All filed records)

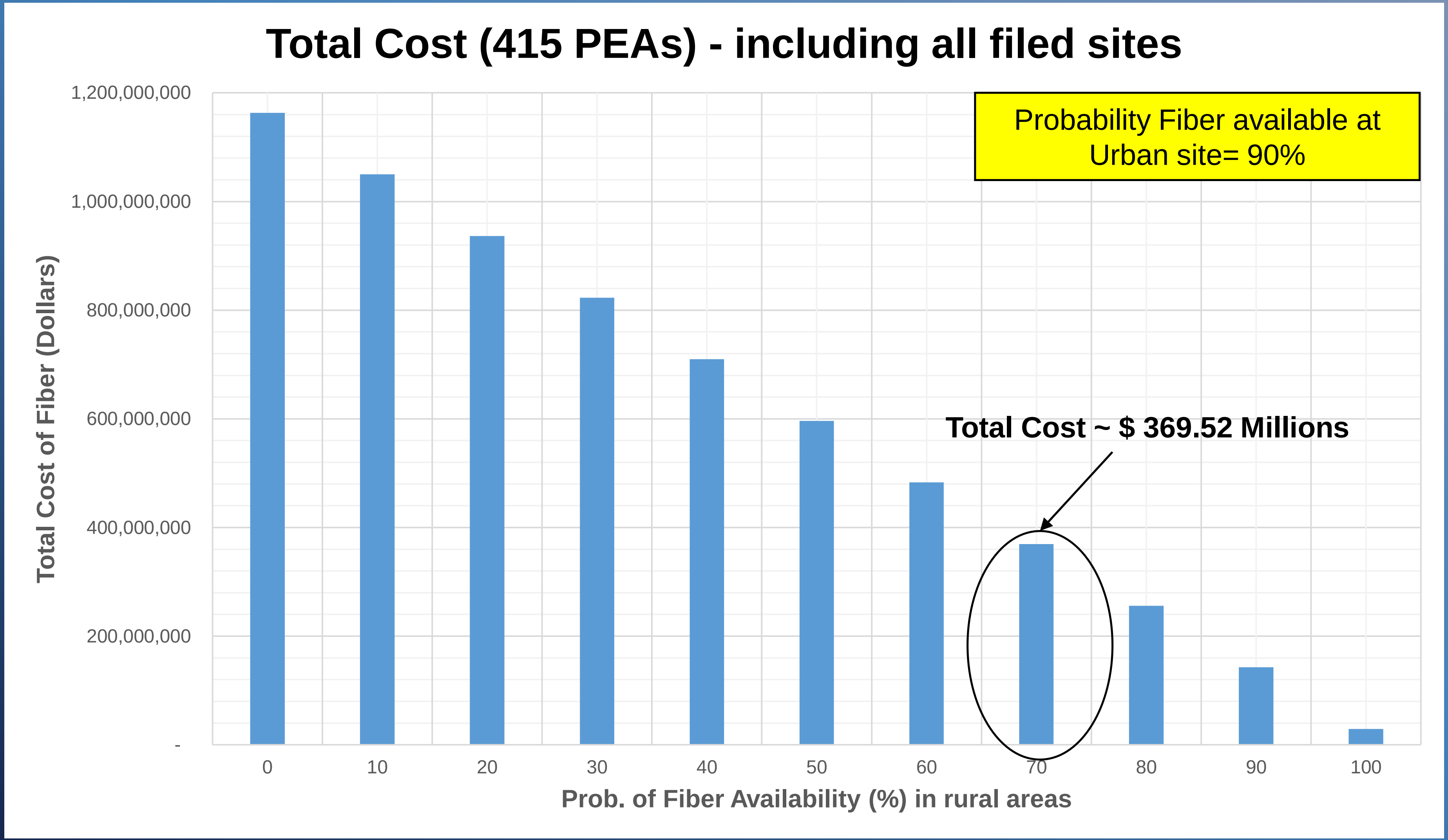
All Filed , Nationwide Replacement in all PEAs Analysis			
# of Satellite C-Band Receivers in urban sites	5,189	# of Satellite C-Band Receivers in rural sites	8,248
Average # of blocks to fiber access	1	Average # of blocks to fiber access	20
Length of city block = 660 x 330 feet	495	Length of a block = 660 feet	660
Average length of fiber (feet)	495	Average length of fiber (feet)	13,200
Cost per foot of fiber wire ($ per foot)	110	Cost per foot of fiber wire ($ per foot)	10
Probability 1 Gbps available (%)	90	Probability 1 Gbps available (%)	70
Cost of wiring urban site with fiber (including laying fiber, fiber termination costs)	56,450	Cost of wiring rural site with fiber (including laying fiber, pole attachment and fiber termination costs	137,500
Cost of replacig satellite w/ fiber for all existing urban sites	29,291,905	Cost of replacing satellite w/ fiber for all existing rural sites	340,230,000

Total Estimated Cost (All 415 PEAs) ~ $ 369.52 Million

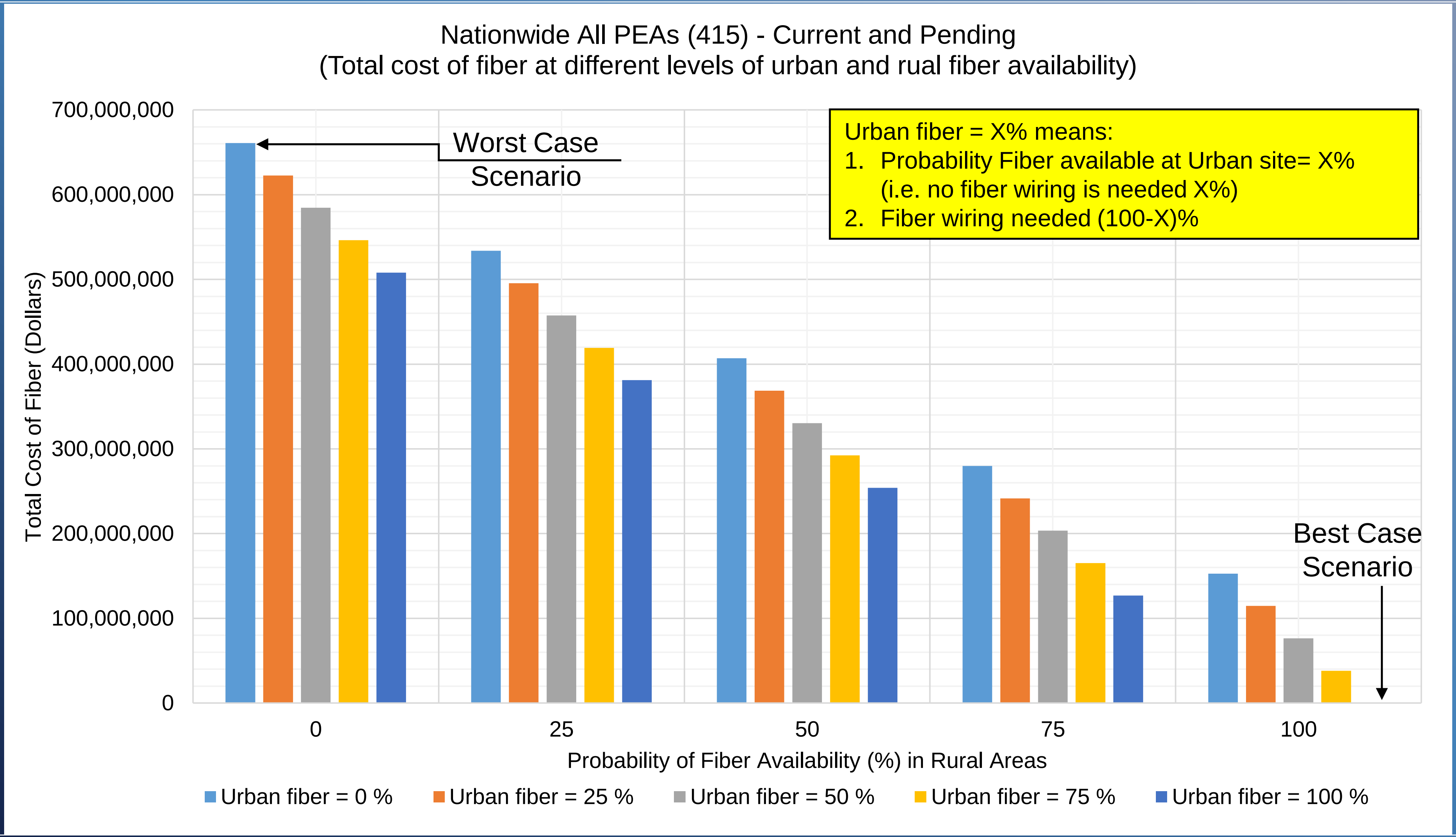
Total Cost (415 PEAs) - current and pending sites



Total Cost (415 PEAs) - including all filed sites



Nationwide All PEAs (415) - Current and Pending



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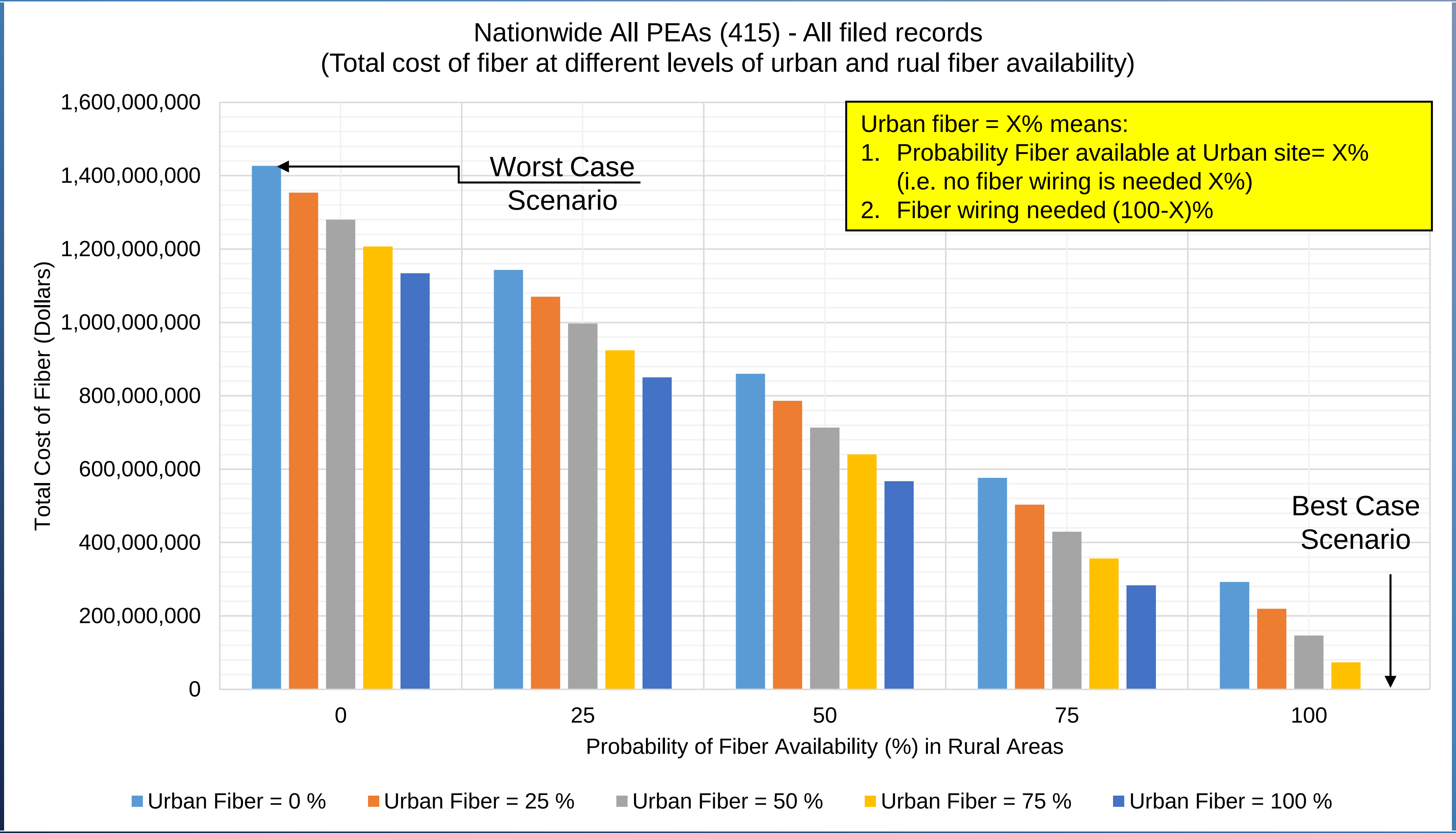
Nationwide All PEAs (415) – All filed records



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Conclusions

- On a nationwide basis, satellite earth stations are located such that:
  - ~ 40 percent are in Urban areas/60 percent are in Rural areas
- Sample "urban" and "rural" PEAs help demonstrate our quantitative analysis of the fiber-replacement cost for all registered earth stations
  - In the Chicago, IL PEA:
    - 33% of all C Band sites are within 100 meters of a fiber run
    - 70% of all C band sites are within 1000 meters of a fiber run
    - 90% of all C Band sites are within 5000 meters of a fiber run
  - In Altoona, PA PEA:
    - 25% of all C Band sites are within 100 meters of a fiber run
    - 63% of all C band sites are within 1000 meters of a fiber run
    - 86% of all C Band sites are within 5000 meters of a fiber run
  - Median distance to fiber in representative urban PEA is 272 meters and 465 meters in rural PEA
- Based on current/pending and all filed records in IBFS:
  - Nominal cost to run fiber to every satellite earth station ranges between $167.70 - $ 369.52 Million
  - Worst case sensitivity case to run fiber to every satellite earth station ranges between $660.92 Million - $1.42 Billion
  - Regulatory or rights-of-way fees could further impact costs
- Estimates are very conservative with no attempt at optimization in this study. Cost of fiber can be further reduced with:
  - Consideration of additional fiber runs that exist but were not considered in this study
  - Optimization of fiber topology to cost efficiently connect clusters of sites